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RESEARCH ARTICLE

Effect of sorting on shelling efficiency of Bambara nut using shelling machine

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ABSTRACT

Bambara nut is grown for its edible seeds. Matured seeds are very hard, so have to be soaked in water to soften before shelling and the manual aspect of shelling is time and energy consuming and as such needs the construction of a moderns heller. It is pertinent to mention that this shelling Machine cannot work effectively if the sorting efficiency is not accurate to ensure effective shelling. This study therefore looks at the effect of sorting on shelling efficiency of Bambara nut using Shelling Machine. Within group design was used and the method involved soaking of a bulk quantity of the pods in ordinary water at room temperature for different periods of time thirty minutes for sample I, one hour for sample II and one hour thirty minutes for sample III. The weight of pods that was completely shelled and unbroken (A), completely shelled but broken (B), partially shelled pods (C) and unshelled pods (D). Result of the finding shows that there was a significant difference in the performance of the machine based on the sorting efficiency. From the result, it was observed that the machine has a very high sorting efficiency and as such, it enhances shelling as it reduces the number of wastages in terms of breakage as well as not shelling. On average, small pods had an average of 3.57 (SD = .220), medium pods had average sorting efficiency of 3.11 (SD = 0.225) while large pods had an average sorting efficiency of 2.57 (SD = .437) thus projecting the machine as having a high level of sorting efficiency. It was recommended that for efficient shelling, Bambara nut should be shelled using the machine that can separate it into various sizes to ensure that the compartments have the right sizes of seeds to ensure effective shelling.

Keywords: Shelling, shelling machine, sorting efficiency, sorting efficiency and pods

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INTRODUCTION

The origin of the Bambara nut (*Vigna subterranean* (L.) verdict) is in West Africa and the region of cultivation is Sub-Saharan Africa's warm tropics (Nichterlein, 2011). World production of *Vigna subterranean* increased from 29 800 tons in 1972 to 79 155 tons in 2005, while the yield during this period did not increase (FAOSTAT, 2009). As an underutilized crop, Bambara nut has not received sustained research. Bambara nut is the third most important grain after Ground nut and cowpea (Ezeaku, 1994). In Nigeria, Bambara nut is widely produced in Borno, Anambra, Plateau, Taraba, Sokoto, Bauchi, Benue, Kano, Yobe, Adamawa and Gombe States (Ezue, 1977; Atiku, 2000). The entire plant is known for soil improvement because of nitrogen fixation. In West Africa, the nuts are used for food and beverage because of its high protein content and for digestive system applications.

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It can be eaten as a snack, roasted and salted, or as a meal, boiled similar to other beans (Data sheet *Vigna subterranean*, 2011). 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. Un dehulled 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 (Enwere and Hung,1996).

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 (Goli,1997). The seed contains about 63% carbohydrate, 19% protein and 6.5% oil. The haul can be used for livestock feed (Tanimu and Aliyu, 1996).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 (Atiku et al., 2004).

According to Atiku et al. (2004) the reduction / elimination of post-harvest losses in shelling of pods to obtain good quality seed is one of the most tedious operations in Bambara nut processing. It has constituted a bottle- neck to the large scale production and processing of this important proteinous crop. In most situations, stones or hammer is used in shelling of this cropor it is placed on the sack and is then beaten with stick. The separation of the nuts from the shells is by local winnowing or by hand picking of one nut after the other, these methods are quite tedious.

According to Negedu et al. (2016), most agricultural materials such as Bambara nut (BGN) cannot be directly consumed by humans when harvested from the farm. This therefore necessitated to check the effect of sorting of the Bambara nut pods on it shelling efficiency due to the fact that the sizes of Bambara nut pods/seed varies and separation of foreign materials from the pure Bambara seed such that it would reduce man energy wasted and many hours involved, drudgery and postharvest losses in the processing of the said material. The specific aim of this study is to test and check the mean sorting efficiency of the Shelling Machine.

MATERIALS AND METHODS

Bulk quantity of Bambara nut pods was purchased from Aga market (Jato-aka) in Kwande Local Government Area in Benue state, Nigeria. Bambara nut pods were cleaned and sampledfor experiment using a multi-slot riffle box divider. The moisture content of the pods was varied using the method reported by Oluwole *et al.* (2004) and Atiku *et al*. (2004). The method which involved the soaking of a bulk quantity of the pods in ordinary water at room temperature for different periods of time thirty minutes for sample I, one hour for sample II and one hour thirty minutes for sample III. Sample II was retained at the stable storage moisture content as a control sample. After soaking the pods were spread out in a thin layer to dry in natural 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 moisture content of the pods to be achieved in the bags.

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 (small, medium and large) 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.

Method of Testing

To conduct a performance test, the first pulley of the Shelling Machine was fixed to the shaft; the two discharge chutes of the hopper were closed using the flow rate control device. The power supply was switched on to run the diesel engine and to put the working components of the machine in operation.

After which, 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.

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Data

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

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

$p_{CS} = 97.9\%$

Percentage of completely shelled and broken seed $p_{CB} = \left(\frac{B}{N_{T-N_{CT}}}\right) \times 100\ \%$

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

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

Percentage of partially shelled and unbroken seed $p_{PS} = \left(\frac{C}{N_{T-}N_{CT}}\right) \times 100\ \%$

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

$p_{PS} = .2\%$

Percentage of completely unshelled $p_{CU} = \left(\frac{D}{N_{T-}N_{CT}}\right) \times 100\ \%$

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

$p_{CS} = .9\%$

Shelling efficiency of the machine, $S_E = \left(\frac{A+B+C}{N_T - N_{CT}}\right) \times 100\ \%$

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

$$S_E = 97.8\ \%$$

RESULTS AND DISCUSSION

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.

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

Table 1: Sorting Efficiency data for testing Shelling Efficiency

Sorting efficiency	weight (kg)of bambara nut pods loaded on the machine	weight (kg) of seed obtained after shelling
Small	10	3.83
Medium	10	3.41
Large	10	3.12

Results in Table 1 show the three sorting efficiencies which are small, medium and large with the respective weight of bambara nut loaded on the machine, the weight of seeds obtained after shelling, their respective mean as well as their standard deviation. One way analysis of variance was used to test the significant difference and the result is presented in Table 2.

Table 2: One way ANOVA for sorting efficiency of the reciprocating cracker

Source	Mean	SD	df	F	P	Remarks
Small	3.57	.220	2, 24	22.119	.000	Sig
Medium	3.11	.225				
Large	2.57	.437				
Total	3.07	.504				

Result in the Table 2 shows that, there is a significant difference in the performance of the machine based on the sorting efficiency (p<.001). From the result on the table, it can be observed that the machine has a very high sorting efficiency and as such, it enhances shelling as it reduces wastages in terms of breakage as well as not shelling. On average, small pods had an average of 3.57 (SD = .220), medium pods had average sorting efficiency of 3.11 (SD = .225) while large pods have an average sorting efficiency of 2.57 (SD = .437) which projected the machine as having a high level of sorting efficiency. Figure 1 is the graphical representation of the shelling efficiencies as grouped and presented in the Table2;

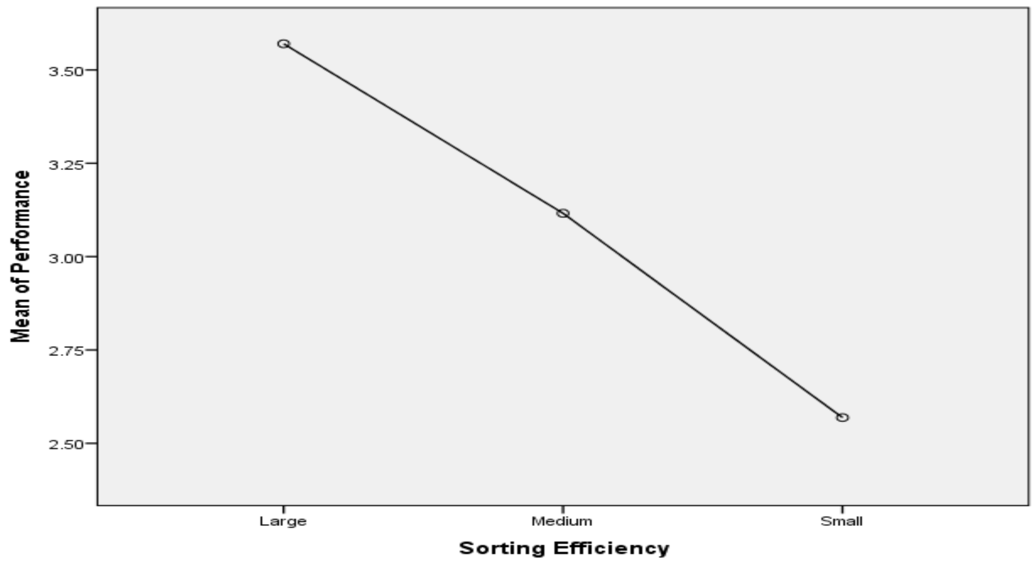

Figure 1: Sorting efficiency of the modified machine

This study is limited to testing and checking the mean sorting efficiency of the machine as well as the cleaning efficiency with the use of bambara nut that was bought from Aga (Jato-Aka) Market, kwande Local Government, Benue State**.**

CONCLUSION

This study reveals that, there is a significant difference in the performance of the machine based on the sorting efficiency(p<.001). From the result, it is observed that the machine has a very high sorting efficiency and as such, it enhances shelling as it reduces the number of wastages in terms of breakage as well as not shelling. The researcher recommends that for efficient shelling, Bambara nut should be shelled using the machine that can separate it into various sizes, as the Shelling Machine has done.

REFERENCES

Atiku, A. A., Aviara, N. A., and Haque, M. A. 2004. Performance evaluation of a Bambara groundnut sheller. Agricultural Engineering. International: CIGR Journal of Scientific Research and Development. 6: 1-10.

Data sheet Vegan Subterranean. 2011. Ecocrop. FAO. Retrieved 18 march 2018.

Enwere, N. J. and 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.

Ezeaku, C.A. 1994. Fracture characteristics of Bambara groundnut in compressive loading. M.Sc. Eng. Thesis, Department of Agricultural Engineering, University of Nigeria, Nsukka.

Ezue, M.I. 1977. Cultivation and utilization of minor Food legumes in Nigeria. Tropical Grain Legumes Bulletin, 10: 7-12.

Goli, A.E. 1997. Bambara groundnut. Bibliographic review. In Bambara groundnut. Vigna subterranean (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.).

Negedu, A. M., Irtwange, S.V and Ijabo, O. J. 2016. Design and fabrication of Bambara Groundnut (Vigna subterranean (L) Verdc) Sorter, Sheller and Cleaning Machine. Department of Agricultural and Environmental Engineering, University of Agriculture, P.M.B 2373, Makurdi, Benue State, Nigeria.

Nichterlein, K. 2011. Vigna subterranean . Ecoport. Retrieved 16th March, 2018.

Oluwole, F. A., Aviara N.A., and Haque M.A., 2004. Development and performance tests of a sheanut cracker. Journal of Food Engineering, 65: 117-123.

Tanimu, B. and Aliyu, L. 1996. Bambara groundnut, country report: Northern Nigeria. In Bambara groundnut. Vegna subterranea (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.