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INVESTIGATION OF SEPARATION OF PALM KERNEL AND SHELL ON AN INCLINED PLANE SEPARATOR

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Abstract: The separation of shell from kernel of two varieties of oil palm in Nigeria was investigated in a laboratory inclined plane separator. Four angles of projection of 25, 30, 35, 40 and 45˚ were used and three structural surfaces namely mild steel, galvanised steel and plywood were used for the separation experiment. Results show that the highest separation of 7.7 and 8.6 cm occurred on mild steel for dura and tenera at angles of projection of 35 and 40º respectively. That of galvanised steel was 8.7 and 9.7 cm at angles of 30 and 25º respectively while that of plywood was 17.0 and 13.0 cm at angles of 30 and 25º respectively. These provide useful guide in the selection of material and angle of projection for separation.
Keywords: Palm kernel, inclined plane separator, angle of projection, oil palm

INTRODUCTION

Processing of palm kernels into palm kernel oil (PKO) and other byproducts involves cracking the palm kernels to obtain palm kernel nuts from where the oil is expressed. In developing countries like Nigeria, cracking is done by manual and mechanical methods. Cracking produces a mixture of broken shells and kernels. The nuts must be separated from the mixture for further processing into PKO. In small scale processing mills, the separation is done manually. However, manual separation is slow, tedious and not suitable for large scale production. Large scale processing mills adopt techniques based on density difference between the kernels and shells to effect separation. The two methods under this technique are clay-bath and hydro-cyclones. The two methods are known as wet processes since water is always involved and the kernels have to be dried at the end of the separation (Okorokwo et al, 2013). This increases both the time and cost of production. Thus their application in small scale mill is difficult (Poku, 2002).

Research efforts are now focused on developing dry separators to ameliorate the limitations of existing methods of separation. Different researchers have developed different dry separators for this purpose, a spinning disc separator (Koya and Faborode, 2006), incline table separator (Akubuo and Eje, 2002), sieve separator (Amoah et al, 2007), tray separator Oke, 2007), angular projection separation (Onaku et al, 2013), winnowing system (Halim et al, 2009), nut and fibre separator (Ologunagba, 2010) and rotary separator (Olasunboye and Koya, 2014). However, the limitation of these separators is low separation efficiency. There is therefore the need to develop dry mechanical separators with high separating efficiency.

This work was therefore carried out to investigate the separation of palm kernel shell and nut on an inclined plane separator using different structural surfaces.

METHODOLOGY

The Inclined Plane Separator

The laboratory inclined plane separator was designed and constructed at the Department of Agricultural and Bioresources Engineering, Federal University of Agriculture, Abeokuta, Nigeria. It consists of a hopper, an adjustable inclined plane and a collector. The material to be separated is poured into the hopper from where it flows into the inclined plane. The coefficient of friction of the components of the material on the inclined plane determines their motion on the inclined plane. The differences in motion cause them to fall at different spots on the collector where separation takes place. The picture and isometric view of the inclined plane separator are shown in Figure 1.

Separation Experiment on a Laboratory Incline Plane Separator

Dura and tenera varieties of palm kernels were obtained from the teaching and research farms of the Federal Universities of Agriculture, Abeokuta, Nigeria. The kernels were manually cleaned to remove foreign materials, dust, dirt and broken kernels. The kernels were then cracked with a palm kernel cracking machine available at the College of Engineering of the University.

The moisture content of the shell and kernel were determined by oven drying method and was found to be 4.5% and 5.0% w.b. for dura shell and kernel while for tenera it was 5.1% and 4.5%. w.b. respectively.

Twenty kernels and shells of each of dura and tenera varieties were randomly selected and poured into the hopper of the separator from where they flow into the inclined plane by gravity. After sliding through the plane the shell and kernel fall into the collector. The base of the collector is filled with sand to enable the range (distance of fall of the kernel and the shell) to be measured. The separating plane of three structural surfaces namely mild steel, galvanized steel and plywood were used. They were inclined at different angles of 25, 30, 35, 40 and 45˚. The difference in the distance of fall of both nut and shell (separation) was determined for each angle. The experiment was repeated five times for each angle and surface.

Figure 1. Picture and Isometric view of the inclined Plane Separator
A – Hopper, B – Frame, C – Surface plane, D – Protactor,
E – Collector, F – Adjuster, G – Screw, H – Base

RESULTS AND DISCUSSION

The separation between the kernel and shell of the two varieties of oil palm on the three structural surfaces are shown in Tables 1 to 3.

Table 1. Average separation on Mild Steel for Dura and Tenera

Angle of Projection (˚)	Dura Separation (cm)	Tenera Separation (cm)
25	6.3	6.3
30	7.4	8.6
35	7.7	7.3
40	7.3	7.7
45	5.3	6.0

Table 2. Average separation on Galvanized Steel for Dura and Tenera

Angle of Projection (˚)	Dura Separation (cm)	Tenera Separation (cm)
25	6.7	9.7
30	8.7	8.3
35	7.6	7.3
40	7.3	7.6
45	5.7	6.6

Table 3. Average separation on Plywood for Dura and Tenera

Angle of Projection (˚)	Dura Separation (cm)	Tenera Separation (cm)
25	10.0	13.6
30	17.0	10.7
35	11.0	10.0
40	10.4	8.8
45	9.3	7.0

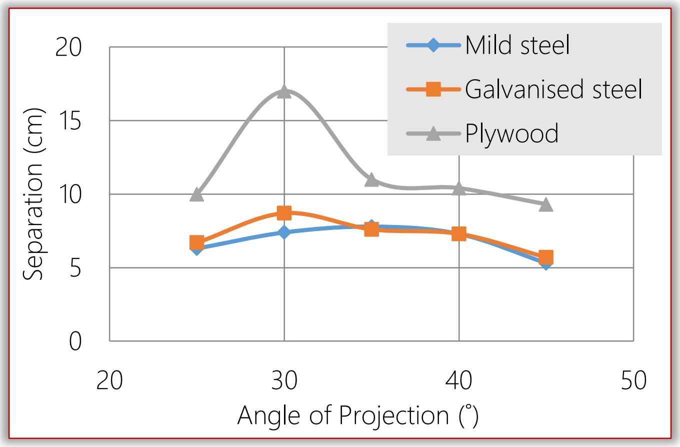

Figure 2. Variation of angle of projection with separation for Dura

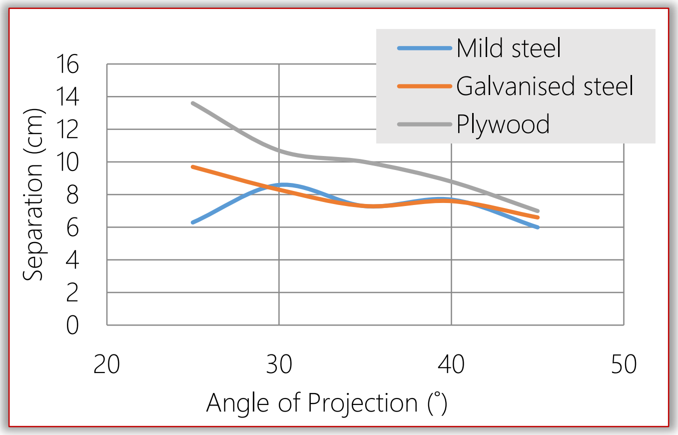

Figure 3. Variation of angle of projection with separation for Tenera

It is observed that the highest separation on mild steel for dura is 7.7 cm at angle of projection of 35° and for tenera it is 8.6 cm at angle of projection of 40°. On galvanised steel the highest separation for dura is 8.7 cm at angle of projection of 30° while it is 9.7 cm at 25° for tenera.

For plywood the highest separation obtained for dura is 17.0 cm at 30° while it is 13.0 cm for tenera at angle of projection of 25°. The trends of separation for the two varieties on the three surfaces are shown in Figure 2 and Figure 3.

It can be observed from Figures 2 and 3 that the highest separation for dura and tenera took place on plywood at angles of 30 and 25° respectively. Mild steel and galvanised steel have similar trend of separation but with galvanised steel having a slightly higher separation at 30 and 25° for both dura and tenera respectively. This is a useful guide in the choice of material and angle of projection for separation.

CONCLUSIONS

- The separation of palm kernel and shell of dura and tenera varieties of oil palm on an inclined plane separator was investigated.
- On mild steel the highest separation for dura is 7.7 cm at angle of projection of 35° and for tenera it is 8.6 cm at angle of projection of 40°.
- On galvanised steel the highest separation for dura is 8.7 cm at angle of projection of 30° while it is 9.7 cm at 25° for tenera.
- The highest separation on plywood obtained for dura is 17.0 cm at 30° while it is 13.0 cm for tenera at angle of projection of 25°.

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