ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

Comparative Evaluation of Mechanized Palm Kernel-Shell Separating Systems in Nigeria

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ABSTRACT: The potentials of recently developed indigenous dry process based palm kernel shell separation systems were analysed and compared to determine the best for adoption by small scale processors in Nigeria. The systems compared were developed and used in Nigeria while kernel/shell purity, recovery and separation efficiencies constitute the evaluation parameters. This review revealed that the efficiencies of angular projection separator, winnowing system, inclined table separator and rotary separator are less than 95%. The kernel purity, kernel recovery, shell purity, shell recovery and separation efficiencies of improved palm kernel dual processing machine are 98%97.9%, 98.2%,98.6% 95.9% and 98% respectively while those of the fragmentation unit enhanced palm kernel and shell separator are 97.9%, 98.2%,98.6% 98.6% and 95.9%. Hence, the fragmentation unit enhanced palm kernel shell separating and improved dual processing machines are most efficient for adoption by small scale oil palm fruit processors because all their performance indicators are over 95%.

KEYWORDS: Dry separation process, mechanized systems, oil palm nut ,palm kernel, shell

I. INTRODUCTION

Oil palm *(Elaeis guineensis)* bears fresh fruit bunch (FFB) which contains many small plumed fruits made up of the pericarp (fibrous oil matrix pulp) and a central nut. The pulp yields the palm oil while the nut consists of a shell and kernel which yields palm kernel oil [1]. Extraction of palm oil and kernel from oil palm fresh fruit brunches is based on two distinct processes, traditional and mechanical methods. Development of mechanized systems for effective processing of oil palm fruits remained the quest of stakeholders in this field due to high drudgery and post-harvest losses associated the traditional and existing mechanized processes respectively. Hence, the operations sequence modification of mechanized palm fruit processing (Fig. 1)and subsequent proposal of 23:20 as the optimal ratio for planting/processing of dura and tenera in this sector by [2] and [3]. This improved process involves separation of digested fruit mash into palm nut and pulp before pressing of the pulp only for palm oil extraction, thereby improving quality and quantity of palm oil and kernel output by eliminating nut breakage and reducing palm oil loss to pressed fibre[4].Although [4] showed that the novelty of nut-pulp separation reduced production time/cost, domination of hand picking method of kernel and shell separation among small scale processors plays down the benefits of the new process. This is why [5] directed for the adoption of wet clay-bath method of palm kernel shell separation by small scale holders due to high cost of hydro cyclone systems in order to reduce drudgery and increase the process speed/throughput. However, high cost of kaolin and sterilization of the separated kernel as well as product wastes associated with wet clay-bath method hinders adherence to this proposal. In addition, separation of kernels which are comparable in size with the broken shellsposes great challenge with this method [6].The clay-bath method also generates waste effluent that harms the environment [7]. Hence, the need to compare the potentials of recently developed indigenous dry process based palm kernel shell separation systems for proper recommendation and adoption.

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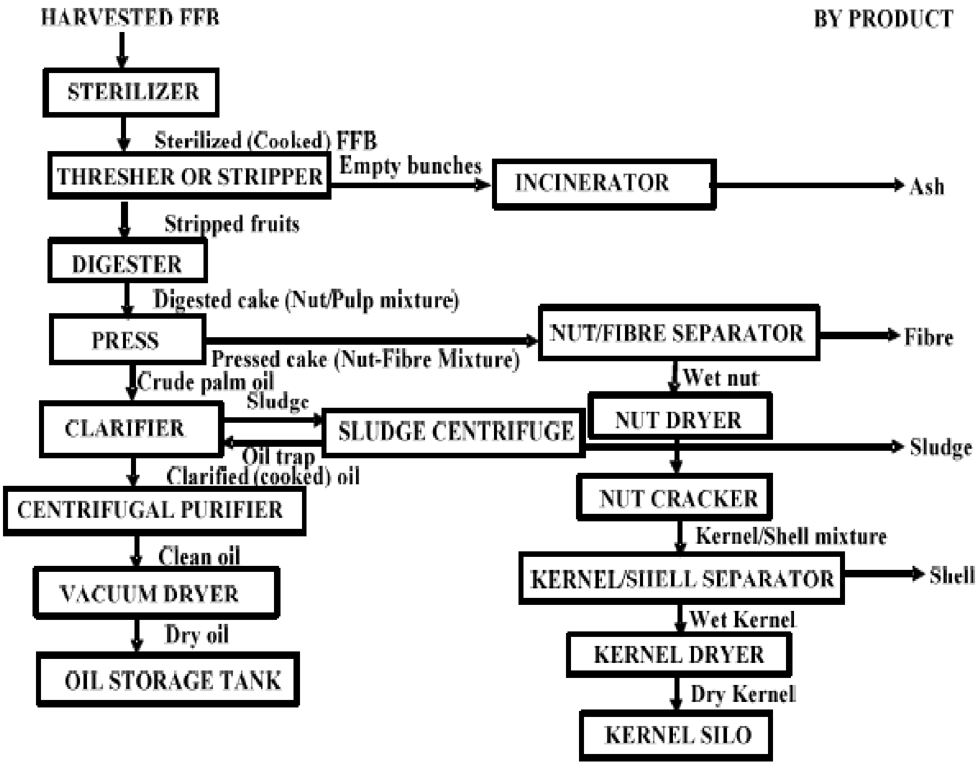

Fig.1: Operation Sequence modified-mechanized palm oil and kernel extraction process [2]

II. METHODOLOGY

This study involves empirical survey of the claimed performance indicators of different mechanized palm kernel-shell separating systems developed in Nigeria. The evaluation parameters include kernel purity, shell purity, kernel recovery, shell recovery and separation efficiencies. Kernel and shell recovery efficiencies are respective percentage of the kernels and shells in the feed mixture recovered which are determined using the following relations [8]:

$$K_r = \frac{100k}{k+e} \qquad (1)$$

$$S_r = \frac{100s}{s+e} \qquad (2)$$

Where K_r is kernel recovery efficiency, S_r shell recovery efficiency, k is mass of the kernels recovered; s is mass of the shells recovered and e is mass of unseparated kernel and shells mixture. Kernel or shell purity are inverse of their contaminants. Kernel contaminant (Kc) refers to the percentage of shell, uncracked nuts and other impurities in the recovered kernels while shell contaminant (Sc) constitutes the percentage of kernels, uncracked nuts and other impurities in the recovered shell [8]. Thus;

$$K_c = \frac{C}{k+C} \times 100 \qquad (3)$$

$$S_c = \frac{f}{s+f} \times 100 \qquad (4)$$

Where C is the mass of shells, uncracked nuts and other impurities found in the kernels while f is the mass of kernels, uncracked nuts and other impurities contained in the shells. Separation efficiency (η) constitutes the percentage of the recovered clean kernels and shells in feed mixture (w).

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$$\eta = \frac{100k\,(k+s)}{W} \qquad (5)$$

III. RESULTS AND DISCUSSION

This review revealed low separation efficiencies of 87%,78.5%, 82% and 94.17% for an angular projection separation [9], winnowing system [10], inclined table separator [11], and rotary separator[12] respectively (Fig. 2).Although the separation efficiency of the rotary separator of 94.17% is approximately within the acceptable 95%, its respective kernel purity, kernel recovery, shell purity, shell recovery and separation efficiencies of 73.12%, 91.89%, 73.66% and 80.16% indicated high material waste associated with its usage. The kernel purity, kernel recovery, shell purity, shell recovery and separation efficiencies of improved palm kernel dual processing machine are 98%97.9%, 98.2%,98.6% 95.9% and 98% respectively [13] while those of the fragmentation unit enhanced palm kernel and shell separator are 97.9%, 98.2%,98.6% 98.6% and 95.9% [14]. Hence, the works of [13] and [14] are the most efficient system for adoption by small scale processor since all their performance indicators are above 95%

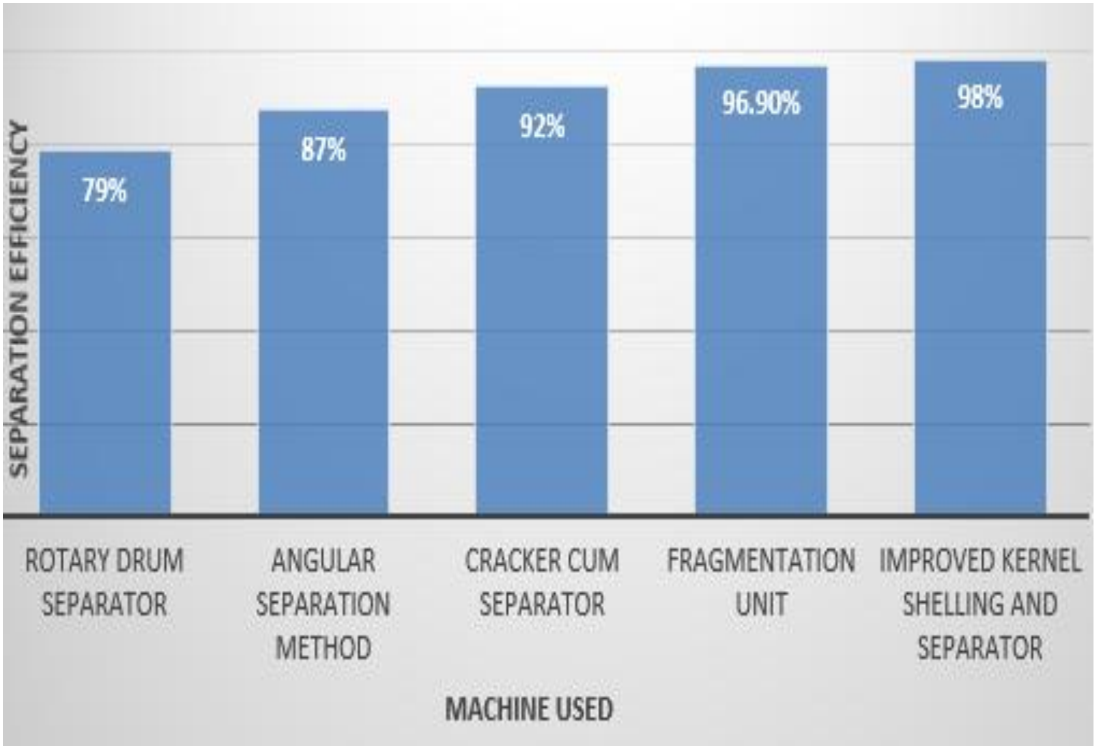

Fig 2: Separation efficiencies of some palm kernel-shell separating machines in Nigeria [7-14]

IV. CONCLUSION

The work revealed that the improved palm kernel dual processing machine and palm kernel shell separator with fragmentation unit are most efficient systems for adoption by small scale oil palm fruit processors This because their kernel purity, kernel recovery, shell purity, shell recovery and separation efficiencies are over 95%.

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ACKNOWLEDGEMENT

Tertiary Education Trust Fund, Abuja Nigeria is highly valued for funding this study.

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