



Determination of the Effects of Parboiling and Frying on the Dehulling Process of African Breadfruit Seeds (*Treculia africana* Decne)

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Abstract – This work investigates the effect of moisture content and frying time on the dehulling processing of the African breadfruit seeds. The seeds were subjected to two different traditional processing methods; parboiling and frying. The parboiled and fried samples were processed at three different levels of moisture contents and frying time intervals of 10%, 15%, 20% and 20 mins, 30 mins, 40 mins respectively. Each of the parameter was tested using 5 different levels of the speed of operation 1300, 1400, 1500, 1600 and 1500 rpm of the breadfruit dehuller. The results obtained showed that both processing methods have significant effects on dehulling operation of the seeds at $p < 0.05$. The 10% MC has performance efficiency of 76.40%, quality efficiency of 70.45%, breakage efficiency of 19.53% while 15% MC has 74.03% performance efficiency, 59.22% quality efficiency, 24.35% breakage efficiency and 20% MC has 73.59% performance efficiency, 55.50% quality efficiency and 28.28% breakage efficiency. This shows that low moisture content favours dehulling processing of the seeds while high moisture content defavours it. Also, for the fried sample, the 20 mins frying time has 76.12% performance efficiency, 54.38% quality efficiency, 32.34% breakage efficiency while 30 mins has 79.02% performance efficiency, 71.73% quality efficiency, 19.58% breakage efficiency and 40 mins has 80% performance efficiency, 58.49% and 48.97% breakage efficiency. Therefore, the optimum frying time is 30 mins since it gives dehulling results. Hence, it can be concluded that processing methods of the seeds affect dehulling operation of the seeds.

Keywords – African Breadfruit Seeds, Dehulling Process, Frying Time, Moisture Content.

INTRODUCTION

African breadfruit (*Treculia africana*) tree is a multipurpose and medicinal plant species which belongs to the family Moraceae and order of Urticales [1]. It grows in many parts of west and tropical African; Nigeria, Senegal, Uganda, Tanzania, Southwest Cameroon, Ghana and Sierra Leone. It is widely found in the forest zone, particularly the coastal swamp zone. Its seeds are commonly called ukwa in Igbo; afon in Yoruba; barafuta in Hausa; eyo in Igala; ize in Benin, Jekri and Sobo; izea in Ijaw; and ediang in Efik [2] and [3].

Breadfruit is a great economic tree. From its leaves, fruits, stem to other parts of the tree such as the root, experts have found *T. africana* Decne and its other variants present in other parts of the world immensely useful in the treatment of many chronic ailments such as diabetes, acute Ischemia and hypertension [4]. While the

seeds, are great sources of carbohydrate and protein. It is a popular traditional food item, commonly roasted, cooked, mashed and consumed either directly as snack food or as flour for use in soup thickening and cakes. The seeds are used as flavouring in alcoholic drinks and edible oil can be processed from the seeds [5]; [6]. [7] reported that the seeds of African breadfruits have an excellent polyvalent dietetic value whose biological value exceeds that of soybeans.

According [8] a mature seed consists of two layers; an outer seed coat and an inner edible endosperm. The husks are coated with a thin viscous highly hydrated layer or mesocarp similar to the coffee bean mucilage. He further explained that African breadfruit is brown in colour but the colour changes black due to oxidation after fermentation period of 6 – 12 days. The fermentation is normally done to degrade the fruit pulp and seed mucilage so as to facilitate the extraction of the seeds. All these processes are considered as the primary processing of the African breadfruit while the process starts with the dehulling operation.

Various works have been carried by some researchers on African breadfruit seeds dehulling machine such as [9]; [10]. However, the seeds have to be processed before undergoing the dehulling operation. There are two major local methods of processing African breadfruit seeds. It is either roasted/fried or cooked/boiled. Therefore, the aim of this study is to determine the effects of the parboiling and frying on the dehulling processing of the African breadfruit seeds.

II. MATERIALS AND METHODS

i) Source of Materials and Sample Preparation

African breadfruit seeds (*Treculia Africana* Decne) were selected for this study. About 100 kg of the fresh seeds was purchased from Ozubulu town in Anambra State (Nigeria). The seeds were manually sorted to remove the spoilt ones and unwanted debris from the sample to be dehulled. Initially, a small quantity of about 200 g was taken and divided into four samples, 50 g each for determination of the average moisture content (MC) of the seeds. On the average, the MC was found to be 13.5%. The moisture content was determined according to the ASAE S410.1 method [11] and expressed as dry basis percentage (% d.b). Due to the nature of the shell of the seeds, they have to be processed before they can be dehulled. The two possible processing of the African

breadfruit seeds usually adopted by local processors are parboiling and roasting/frying process. Some of the seeds were roasted at 3 different frying time intervals of minutes while some were parboiled and the moisture content adjusted to 3 different levels of percentages.

ii) Moisture Content Determination

The moisture content of the seeds (MC) was determined according to the ASAE S410.1 Method [11]. The moisture content of the dehulled African breadfruit seeds was determined from a sample of 200 grams and was expressed as dry basis percentage (% d.b.). [12] gave the expression for obtaining the amount of bone dry matter based on the initial moisture content of the sample using the equation expressed below:

$$MC_{db} = \frac{100(\%MC_{wb})}{100 - (\%MC_{wb})} \quad (1)$$

Where,

$$MC_{db} = \frac{(M_w)}{(M_{dm})} \times 100\% \quad (2)$$

$$M_w = \frac{MC_{db} \times M_{dm}}{100} \quad (3)$$

$$M_{dm} = M_s - M_w \quad (4)$$

Whereas;

MC_{db} = Moisture content dry basis,

MC_{wb} = Moisture content wet basis,

M_s = Mass of sample,

M_w = Mass of water,

M_{dm} = Mass of bone dry matter

ii) Moisture Content Adjustment

The desired moisture content was obtained by drying the grains in a convection air oven at 103°C and by spraying with pre-calculated amounts of distilled water, and then thoroughly mixing and sealing them in separate polyethylene bags. The samples were kept in a dry place (refrigerator of 4°C) for 4 days to equilibrate i.e to allow a homogeneous moisture distribution. [13] gave the equation below for estimating the amount of required to condition sample to desired moisture content;

$$W_m = W_s \left[\frac{M_1 - M_2}{1 - M_1} \right] \quad (5)$$

Where;

W_m = Moisture to be added,

W_s = Weight of the seed sample for which moisture is to be adjusted,

M_1 = Initial moisture content of the sample,

M_2 = Final moisture content of the sample

iii) Parboiled Sample

500 g of the seed sample was taken and parboiled for 15 minutes and air cooled for 1hr before the moisture content of the seed was determined using oven method at 103°C and later adjusted for 10% using moisture content adjustment method by [13]. The seed sample was dehulled at 5 different levels of speed 1300, 1400, 1500, 1600 and 1700rpm. This process was repeated for 15% and 20% moisture content of the seeds with the same 500g of seeds sample each. After the parboiled seeds moisture content

determination, the seeds were dehulled using a breadfruit seed dehulling machine. The data collected were subject to further analysis.

iv) Fried Sample

Also, 500 g of the seeds sample was taken and fried in a frying pan for 20 minutes using a heat regulatory gas cooker. This is to ensure that the same amount of heat is used throughout the frying operation for all frying time intervals. After, the duration of 20 minutes frying time, the fried sample was air cooled for about 1hr before it was dehulled using a dehulling machine at 5 different speed levels of 1300, 1400, 1500, 1600, and 1700 rpm of the machine's petrol engine. This process was repeated for 30 and 40 minutes frying duration time known as processing period. The data obtained were using a statistical tool.

v) Dehulling Test

To determine the effects of the parboiling and frying time on the dehulling operation of the African breadfruit seeds, the dehulling efficiency, quality efficiency and breakage efficiency of the dehuller were evaluated with respect to moisture content of 10%, 15% 20% and 20 minutes, 30 minutes, 40 minutes frying time intervals at 5 different speed levels of operation of 1300, 1400, 1500, 1600, and 1700 rpm using equations below:

Dehulling Efficiency, D_e

$$D_e = \frac{\text{Mass of de hulled seed /bean (kg)}}{\text{Total Mass of breadfruit fed into the machine (kg)}} \times 100 \quad (6)$$

Quality Efficiency, Q_e

$$Q_e = \frac{\text{quantity discharge - destroyed (kg)}}{\text{quantity of breadfruit fed into the machine (kg)}} \times 100 \quad (7)$$

According to [14], the formulas listed below are used to estimate the quality efficiency;

Percentage partially cracked, $\tilde{\eta}_{pc}$ (%)

$$\tilde{\eta}_{pc} = \frac{M_{pu} + M_{pb}}{M_b} \times 100 \quad (8)$$

Mass of bean partially cracked and unbroken = M_{pu}

Mass of bean partially cracked but broken = M_{pb}

Mass of the seed fed into the machine = M_b

Percentage effective of breakage, $\tilde{\eta}_{eb}$ (%)

$$\tilde{\eta}_{eb} = \frac{M_{cb} + M_{pb}}{M_b} \times 100 \quad (9)$$

Mass of the bean completely cracked but broken = M_{cb}

Mass of the bean partially cracked but broken = M_{pb}

Mass of the seed fed into the machine = M_b

Percentage of un-cracked, $\tilde{\eta}_u$ (%)

$$\tilde{\eta}_u = \frac{\text{Mass of uncracked bean and unbroken}}{\text{Mass of seed fed into the machine}} \times 100 \quad (10)$$

Mass of the un-cracked and unbroken bean, M_{uu}

Mass of the seed fed into the machine = M_b

vi) Statistical Analysis

The data were subjected to analysis of variance using SPSS software. Least Significant Difference test was used to separate means that were significantly different from each parameter at $p < 0.05$. The inferential analysis was also used to test for association (correlation) and magnitude (regression) of the relationships among the parameters of the study. Statistical quality control was used to calculate the proportion or percentage rejected lots during quality efficiency evaluation.

III. RESULTS AND DISCUSSION

The table 1 below shows the regression result obtained from the analysis of the individual and joint effect of speed of dehuller and moisture content on the efficiency of the machine for the parboiled seeds. This statistical tool was used to find the magnitude of the effect one parameter of the study has on the other. It was observed that both the speed and moisture content have significant effect on the efficiency of the machine. The result showed that 100% increase in the speed will increase the efficiency of the machine by 1.9% whereas 100% increase in the moisture content will decrease the efficiency by 34.9%. The F-statistic is 139.470 and associated p-value of 0.000. On the ground that the p-value is less than 5%, it is concluded that the speed and moisture content jointly explained the

efficiency of the machine. The R-square showed that 95.9% of variation in the efficiency of the machine is explained by speed and the moisture content.

Similarly, table 1 presents the individual and joint effect of speed of dehuller and frying time on the efficiency of the machine used for fried seed. It was observed that both speed and time of frying have positive and significant effect on the efficiency of the machine. It was found that 100% increase in both the speed and time of frying increase the efficiency by 1.2% and 11.7% respectively. Besides, both variable jointly and significantly explained the efficiency with F-statistic of 23.413 and associated p-value of 0.000. The R-square of 0.796 showed that both variables explained 79.6% of variation in the efficiency of the machine.

Table 18: The Regression Result of the Efficiency of the Machine for both Parboiled and Fried Seeds

Coefficients ^a								
Seed	Model	Unstandardized Coefficients		Standardized Coefficients	T	P-value	F-statistic	R-square
		B	Std. Error	Beta				
Parboiled	(Constant)	51.929	2.033		25.538	.000	139.470 (0.000)	0.959
	Speed (rpm)	.019	.001	.863	14.712	.000		
	MC (%)	-.349	.044	-.463	-7.906	.000		
Fried	(Constant)	55.154	3.283		16.801	.000	23.413 (0.000)	0.796
	Speed (rpm)	.012	.002	.784	6.012	.000		
	Time (min)	.117	.036	.426	3.268	.007		

a. Dependent Variable: EFF (%)

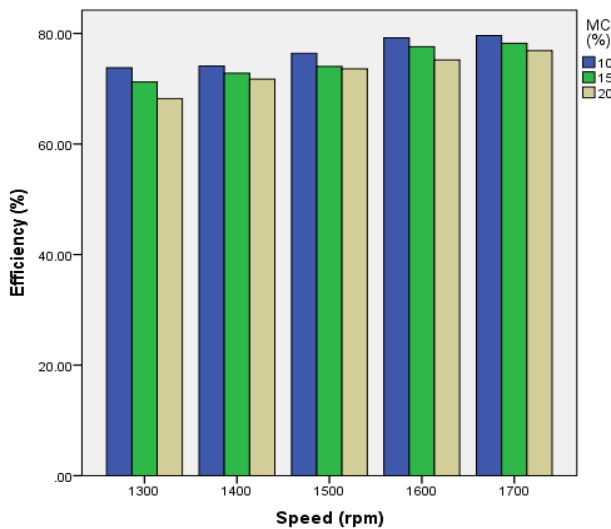


Fig. 1. Efficiency as a Function of Speed and Moisture Contents

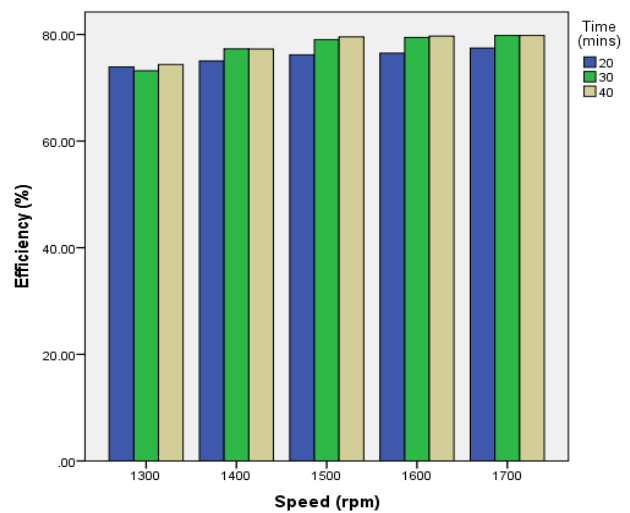


Fig. 2. Efficiency as a Function of Speed and Frying Time

In table 2 below an ANOVA test was used to check if there significant difference within the various moisture contents (10%, 15% and 20%) with respect to the dehulled mass of the parboiled sample. The information contained in the table (p-value 0.234 for parboiled i.e greater than 0.05) showed that there is no significant difference in the dehulled mass as with respect to changing in moisture content in the parboiled seed.

Similarly, table 2 also presents the mean difference of dehulled mass with changing in frying time (mins) for fried seeds. The information contained in the table (p-value is 0.246 i.e greater than 0.05) which means that there is no significance difference in the dehulled mass with respect to changing in frying time.

Table 2: The ANOVA test for the Dehulled Mass of the Seeds (Parboiled and Fried)

Seeds		N	Mean	Std. Deviation	Std. Error	Minimum	Maximum	F-statistic	P-value
Parboiled	10%	5	383.1080	13.68400	6.11967	368.95	398.04	1.645	0.234
	15%	5	373.8880	15.18450	6.79072	356.16	391.10		
	20%	5	365.6380	16.69802	7.46758	341.11	384.40		
	Total	15	374.2113	15.92475	4.11175	341.11	398.04		
Fried	20min	5	379.0060	6.83515	3.05677	369.54	387.18	1.579	0.246
	30min	5	388.7240	13.60999	6.08657	365.94	398.95		
	40min	5	390.6660	11.78373	5.26984	371.79	398.95		
	Total	15	386.1320	11.56814	2.98688	365.94	398.95		

Table 3 shows an independent t-test result. An independent t-test is a statistical tool that was used to check the difference in the dehulling efficiency of the machine when parboiled and fried seed are used. From the table, the mean efficiency of the machine for the parboiled and fried seeds were observed to be 74.8% and 77.0%

respectively with t-statistic value of 2.346 and associated p-value of 0.027. On the basis that the p-value is less than 0.05, it is concluded that there is a significance difference in the efficiency of the machine when parboiled and fried seeds are used. Hence, fried seeds samples produce higher efficiency than parboiled.

Table 3: The Independent t-test

	Seeds	N	Mean	Std. Deviation	Std. Error Mean	t-statistic	P-value
EFF (%)	Parboiled	15	74.8427	3.18561	.82252	2.346	0.027
	Fried	15	77.2267	2.31259	.59711		

Table 4 below presents the summary results of the performance, quality and breakage efficiency of both the parboiled and fried seeds.

Table 4: Performance, Quality and Breakage Efficiency of the Parboiled and Fried Seeds

Seeds		N	Performance Efficiency (%)	Quality Efficiency (%)	Breakage Efficiency (%)
Parboiled	10	5	76.40	70.45	19.53
	15	5	74.03	59.22	24.35
	20	5	73.59	55.50	28.28
	Total	15			
Fried	20	5	76.12	54.38	32.34
	30	5	79.02	71.73	19.58
	40	5	80	58.49	48.97
	Total	15			

IV. CONCLUSION

The effects of parboiling and frying time on the dehulling process of African breadfruit have been determined. From the results, it was observed that both moisture content and frying time have significant effect on the dehulling operation of the African breadfruit seeds. Low moisture content for parboiling method enhances higher dehulling efficiency, quality efficiency and favourable seed breakage amount. While for the frying time, it was found that there is an optimum frying time which is 30 minutes at which African breadfruit seeds dehull properly. Any time below or above that, the seeds will either not be fried properly or over fried which usually lead to excessive breakage of the bean during dehulling operation.

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