

Effect of Soaking Period and Operating Speed on Performance of a²⁸¹ Soybean Dehulling Machine

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Abstract

The effect of soaking period and operating speed on dehulling efficiency of soybeans dehulling machine was investigated using a full factorial design to develop an experimental design of two factors (soaking period and operating speed), three levels design and the response was chosen to be the percentage dehulling efficiency. It was observed that dehulling efficiency ranging from 45.4 to 81.8% was obtained. The response obtained were subjected to statistical analysis and it showed that all the individual factors considered have a significant effect on dehulling efficiency of soybeans dehulling machine.

Keywords; Performance; Soybean; Soaking period; Operating Speed; Efficiency.

1.0 Introduction

Soybean is an important leguminous oil seed usually grown as a food crop (Akintola, et al., 2018). Soybean is becoming increasingly important because it is a food source in human and animal nutrition. Soybean is among the major industrial and food crops grown in every continent (Adekanye, 2016). The expansion of Soybean cultivation in Nigeria has expanded as a result of its nutritive and economic importance and diverse domestic usage. Soybean has an average protein content of 40% and is more protein-rich than any of the common vegetable or animal food sources found in Nigeria (Adekanye, 2016).

Soybean processing is faced with many challenges which hinder its acceptability and popularity in Nigeria, this is mainly due to lack of processing technologies suitable for farmers and processors in rural areas. One of the operations that pose a challenge on soybean processing is dehulling, dehulling tends to be the most tedious and time consuming in the unit operation. Mortar and pestle, hand rubbing and grinding stone are used traditionally to de-hull the seed (Akintola et al., 2018) which resulted into time and economic loss, reduction in products quality and drudgery. The development of soybean hulling machine has proven to eliminate the problems associated with traditional methods of dehulling as reported by Akintola et al., (2018). Soybean dehulling is commonly done using the wet method whereby soybeans were soaked for a prolonged period of time before been dehulled in a dehulling machine to remove the hulls. The main objective of this study was therefore to investigate the effect of soaking period and operating speed on dehulling efficiency of soybeans dehulling machine in other to provide the best combination of dulling parameters that affect dehulling efficiency which will effectively result to best performance of the machine.

2.0 Methodology

2.1 Sample Collection and Preparation

Soybeans seeds were obtained from local market in Igboora, Oyo State, Nigeria. The seeds were cleaned and sorted to remove impurities.

2.2 Experimental Design

After the soybean seeds were obtained and prepared, the experiment to be carried out were designed with the aid of Minitab 18 software using full factorial design. In designing the experiment, the factors considered were the soaking period at room temperature and operating speed. While, the response of each experiment was chosen to be the weight of dehulled and percentage efficiency. The levels used for the factors are given in table 1. A total of nine experimental runs were obtained and the experiment was carried out using an existing soybean dehulling machine which consists of two hoppers (water inlet and seed inlet), two semi-concentric cylinders (one perforated to allow the hull to pass through it and the other not perforated) and a drive mechanism.

Table 1 Factors and their Levels for Full Factorial Design

Variables	Symbol	Levels		
Soaking Period (min)	X ₁	120	240	360
Operating Speed (rpm)	X ₂	400	600	750

2.3 Performance Index

The performance index used was dehulling efficiency (%)

$$\text{Dehulling efficiency (DE\%)} = \frac{\text{weight of dehulled seeds}}{\text{total weight of input seeds}} \times 100 \quad (\text{Khurmi, R.S, 2006}) \quad (\text{I})$$

2.4 Analysis of Data

The results obtained from the experiment were analyzed to determine the effects of soaking period and operating speed on the performance of the dehulling machine.

3.0 Results and Discussion

Table 2. Factors Considered and Responses

Run order	soaking period (min)	operating speed (rpm)	weight of dehulled seeds (kg)	Dehulling efficiency (%)
1	120	400	2.56	51.2
2	120	600	2.71	54.2
3	120	750	2.23	45.4
4	240	400	3.26	65.2
5	240	600	3.48	69.6
6	240	750	3.17	63.4

7	360	400	3.83	76.6
8	360	600	4.09	81.8
9	360	750	3.79	75.8

The results obtained after dulling of the seeds at different soaking periods and operating speeds developed through the experimental design were presented in table 2. Different levels of soaking periods and operating speeds were combined in the experiment to obtain the dehulling efficiency as the response. It was observed that the highest efficiency of 81.8% was obtained at soaking period of 360min and operating speed of 600rpm. While, a low efficiency value of 45.4% was obtained at 120min soaking period and operating speed of 750rpm. The result range of 45.4% to 81.8% obtained in this study were found to be lower than the value reported by Akintola, A. et al., (2018) with the efficiency of the machine ranging from 87% to 93%. The lower result obtained in this study maybe due to the increase in input load from 2kg to 5kg.

3.1 Effect of Soaking Period and Operating Speed on Dehulling Efficiency.

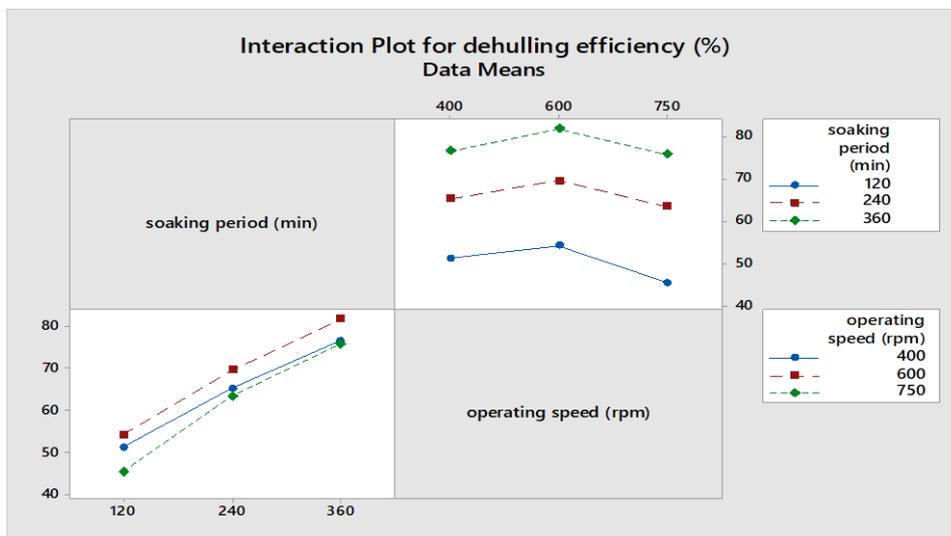


Figure 1 Interaction effect of soaking period on dehulling efficiency

The effect of soaking period and operating speed on dehulling efficiency was study using the interaction plot as presented in figure 1. The result showed that the mean dehulling efficiency increases as the soaking period increases as reported by Akintola, et al., (2018). These could be attributed to the fact that, the longer the soaking period, more water is absorbed and the weaker the adhesive force between the hulls and the cotyledons of the soybean seed.

The increase in operating speed from 400rpm to 600rpm resulted in an increase in dehulling efficiency of the dehulling machine. But, a decrease in dehulling efficiency was recorded at the increase of operating speed to 750rpm. These can be attributed to the fact that the number of turns of conveying auger per time is expected to increase as the operating speed increases which reduces the time spent by the seeds within the dehulling chamber for effective dehulling.

Table 3. Analysis of Variance (ANOVA)

Source	DF	Adj SS	Adj MS	F-Value	P-Value
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Model	4	1240.96	310.240	174.29	0.000
Linear	4	1240.96	310.240	174.29	0.000
soaking period (min)	2	1166.48	583.240	327.66	0.000
operating speed (rpm)	2	74.48	37.240	20.92	0.008
Error	4	7.12	1.780		
Total	8	1248.08			

Table 4 Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.33417	99.43%	98.86%	97.11%

The ANOVA result presented in Table 3 showed that all the individual factors considered were all significant, while the model was also significant. From the results obtained, it was discovered the entire model was significant with a p-value of 0.000 based on 95% confidence level. Also, each of the terms of the model was found to be significant as result of the obtained p-value was lesser than 0.05. The results obtained indicated that soaking period and operating speed has a significant effect on dehulling efficiency of soybean dehulling machine.

4.0 Conclusion

The effect of soaking period and operating speed on dehulling efficiency of soybeans dehulling machine was investigated by varying three levels of soaking period (120min, 240min and 360min) and operating speed (400rpm, 600rpm and 750rpm). a full factorial designed was developed and the res ponse was chosen to be the percentage dehulling efficiency. It was observed that the highest efficiency of 81.8% was obtained at soaking period of 360min and operating speed of 600rpm. While, a low efficiency value of 45.4% was obtained at 120min soaking period and operating speed of 750rpm. The response obtained were subjected to statistical analysis and it showed that all the individual factors considered were all significant with a p-value lesser than 0.05. The results obtained indicated that soaking period and operating speed has a significant effect on dehulling efficiency of soybean dehulling machine

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