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Effect of Moisture Content on Dehulling of Soybean Dehuller

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Abstract

Soy bean is a protein and fat rich crop with very wide ranges of health and medicinal benefits. Its seed is covered by hull which needs to be removed before its use as soy dal or making milk and milk products from soybean. A soybean dehuller for such applications was developed by CIAE, its dehulling efficiency was evaluated under present study. For this purpose soybean Samples of 5 kg each was prepared at different moisture content, the moisture level was increased by addition of measured amount of water and conditioning for 24 to 60 hrs. The five moisture levels selected 9, 11, 13, 15, 17 and 19% (w b).

During study the results obtained were very encouraging. It was found that dal recovery increased with increase in moisture content. The mass of soybean passing out unhusked through the dehuller increased with increase in moisture content. This increase was very sharp after 15%(w.b) moisture content. The dehulling efficiency decreased with increase in moisture content. The rate of decrease becomes steeper after 15% moisture content (w b). The capacity of machine was found to be highest i.e. 96.2 kg/hr at 9% moisture level, and it decreased with increase in moisture content. The mathematical models were also developed to predict the correlation between different variables under study within the range of recorded observations.

Keywords : Please Add Some Keywords

Introduction

India with the production of approximately 1 million ton from about 1-3 million hectare area is placed in five largest soybean producing countries of the world. Although its share is little over 1% of total world production. Out of the total product of India, Madhya Pradesh alone contribution about 80% to the national granaries.

Soybean offers numbers of reasons to be one of the most economical and valuable agricultural products. Some of them may be, it has good adoptability towards wide range of soil and climatic conditions, it has unique chemical composition of 40% protein and 20% oil, its protein has higher proportion of unsaturated fatty acids; it has several health benefits. Its hull although contains very good quality dietary fibers but it needs to be recovered for its use as soy dal or for preparation of milk and milk products from soybean. The machine used to remove the hull is called soybean dehuller. Such a soybean dehuller was designed and developed by CIAE Bhopal. Therefore, in the light of above facts it was decided to test the performance of CIAE soybean n dehuller with following objective ***to study the effect of moisture content on dehulling efficiency***

Material and Methods

The soybean was procured from research farm of college of Agriculture, Jabalpur. Samples of 5 kg was prepared at different moisture content whenever necessary the moisture level was increased by addition measured amount of water and conditioning for 24 to 60 hrs. The five moisture levels selected 9, 11, 13, 15, 17 and 19% (wb). Various other equipments used were :

Stop Watch

A stopwatch was used to record the time required in dehulling. It had a range of 30 min. and seed of 1 min. for 2 revolutions.

Electronic Balance

It was used to weight the samples. Its capacity was 6 kg and accuracy was 10^{-4} kg.

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Digital Moisture Meter

(Burrows model 700) It was used to measure the moisture content of soybean. It required samples in the size of 250 gm. It had the range of 5% to 35% (wb) and least count of 0.1% moisture content (wb).

CIAE Soybean Dehuller

Soybean dehuller designed by CIAE was used for performance evaluation. It had a capacity it 9.6 kg/hr (for soybean having moisture content 7%) and dehulling efficiency of 95%.

Experimental Design

The details of various parameters are given below :

S.N.	Parameters		No. of Levels	Value
	Independent	Dependent		
1.	Moisture content (wb)	--	6	9,11,13,15, 17 & 19

Procedure

Every day a 5 kg sample of soybean was prepared and its moisture was determined. As per the requirement measuring amount of water was added and the soybeans were conditioned to attain the design moisture levels at certain intervals the moisture was sorted and as soon as the designed moisture level was reached the soybeans were subjected to dehulling and the data were recorded. The data so obtained were utilized for calculation of feed rate, capacity and dehulling efficiency. The dehulling efficiency was calculated using following equation :

$$\eta = \left(1 - \frac{Mb}{Mt}\right)\left(1 - \frac{Muh}{Mt}\right) \times 100$$

When, η = dehulling efficiency
Mt = Mass of total grains
Mb = Mass of broken grain
Muh = Mass of unhusked grains.

Result and Discussion

Performance evaluation of Soybean dehuller developed in CIAE Bhopal was the objective of this experiment. To evaluate the performance the moisture content of the Soybean was taken as the independent variable. Based upon preliminary observation it was decided to go for dehulling operations at six moisture levels of Soybean mainly 9%, 11%, 13%, 15%, 17% and 19% wb. Also based upon the preliminary observations it was decided to fix the sample size at 5 kg of whole Soybean.

After finalizing the experimental setup the required sample of 5 kg of conditioned Soybean was fed into the hopper of Soybean dehuller and the machine was started. The stopwatch used for calculation of feed rate was started simultaneously with the opening of feed shutter fixed at the bottom of the hopper.

The various dehulled component were collected from their respective outlets. Various data recorded were analyzed and discussed to obtain the different indicators of machine performance, results are as below :

Recovery of Soy Dal

Recovery of soy dal was found to be maximum at 9%, moisture content of whole soybean (i.e. 4059 gm) and it decreased with increase in moisture content of soybean (Fig. 1). This trend was same for all the five replications of observation. Lowest value of dal recovery (i.e. 2100.7 gm) was observed at the highest moisture level (i.e. 19% moisture content w.b.). It can be seen from fig 8,9,10,11, and 12 that with increase in moisture content decrease in dal recovery is mainly due to short increase in the mass of unhusked soybean coming out of the dehuller.

The data obtained were analyzed statistically to give the coefficient of correlation between the dal recovery and moisture content; the data obtained are representative of a very strong negative association between the moisture content and dal recovery i.e. with increase in moisture content the dal recovery decreases. A second order polynomial was also developed based upon the method of least sum of squares using MS Excel of MS Office 2000. The equation and R^2 values for the average value of all the five replication is tabulated as below :

Replication	Second Polynomial	R^2 Value
Average	$Y = -22.109 X^2 + 444.32X + 1807.4$	0.9952

Dehulling Efficiency

Dehulling efficiency is the parameter which is directly a measure of performance of the machine.

It is calculating using the following equation.

$$N = \left(1 - \frac{M_b}{M_t}\right)\left(1 - \frac{M_{uh}}{M_t}\right) \times 100$$

From the above expression. It can be seen that the dehulling efficiency has got reverse association with mass of broken and mass of unhusked soybean coming out of the dehuller. Dehulling efficiency has the highest value of 94% at 9% moisture content and the lowest value of 53% at 19% moisture content. The decrease in the dehulling efficiency is mainly due to increase in the mass of unhusked soybean coming out of dehuller.

It can be seen from figure No. 5 that the dehulling efficiency has got a strong negative association with the moisture content of soybean. The strong association is conform by a high correlation coefficient between the dehulling efficiency and the moisture content of soybean. A second order polynomial was also developed by the method of least sum of square using MS Exel and MS office 2000.

The second order polynomial and R^2 value for the average of 5 replication is tabulated as below:

Replication No	Second Polynomial	R^2 Value
Average	$Y = 0.4464 X^2 + 8.5486X + 52.595$	0.9931

Capacity

The capacity of the soybean dehullar was calculated based upon the time taken by the machine to dehull the 2 kg of whole soybean. The feed rate of the machine obtain for 2 kg of soybean when express

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in terms of amount of soybean dehulled per unit of time in kg/hr gave the capacity of machine. The maximum capacity of machine was found approximately 96 kg/hr at 9% moisture content and minimum capacity was found to be about 19 kg/hr at 19% moisture content. This sharp decrease in capacity was mainly due to the fact that at higher moisture content. The feed rate was maintained at very low level because even a slight increase in feed rate resulted in the choking of the machine. This choking during dehulling at higher moisture content was mainly due to greater toughness, flexibility and fibrousness of the hull at high moisture content.

It can be seen from figure No 6. That the feed rate has a strong negative association with the moisture content of soybean i.e. with the increase in moisture content feed rate decreases. The second order polynomial shows the regression equation of feed rate on moisture content was calculated based on the method of least sum of squares using MS Exel and MS Office 2000. The Regression equation and R2 value for different replication are tabulated as below:

Replication No	Second Polynomial	R2 Value
Average	$Y = -0.7709\ X^2 + 14.091X + 26.766$	0.9663

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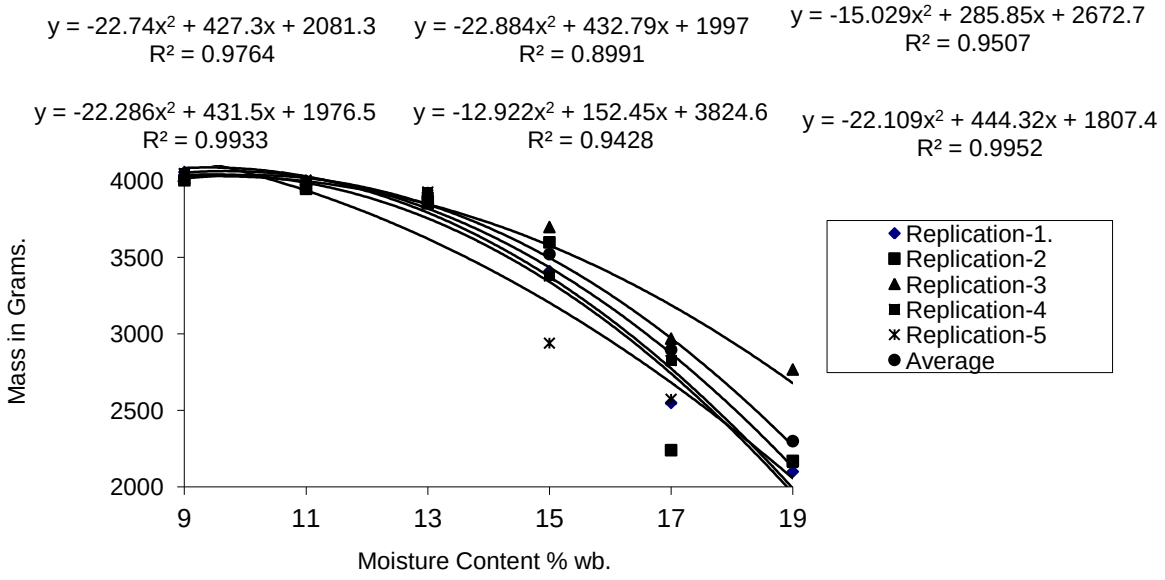

Fig. 1 : Variation inRecovery of Dal with Moisture Content of Soybean.

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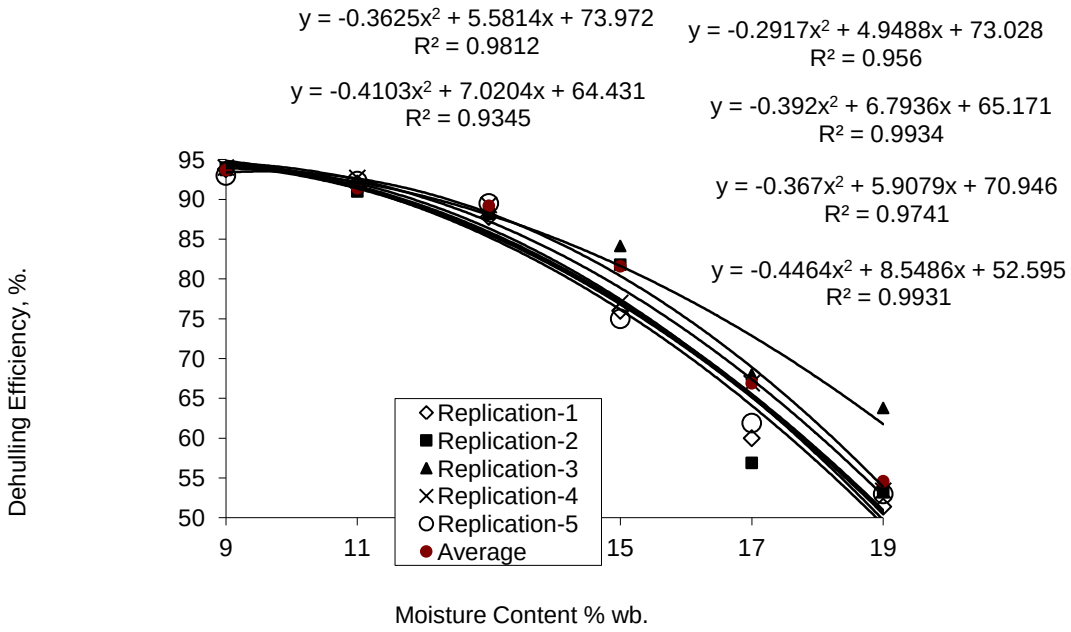

Fig.5 : Variation in Dehulling Efficiency with Moisture Content of Soybean.

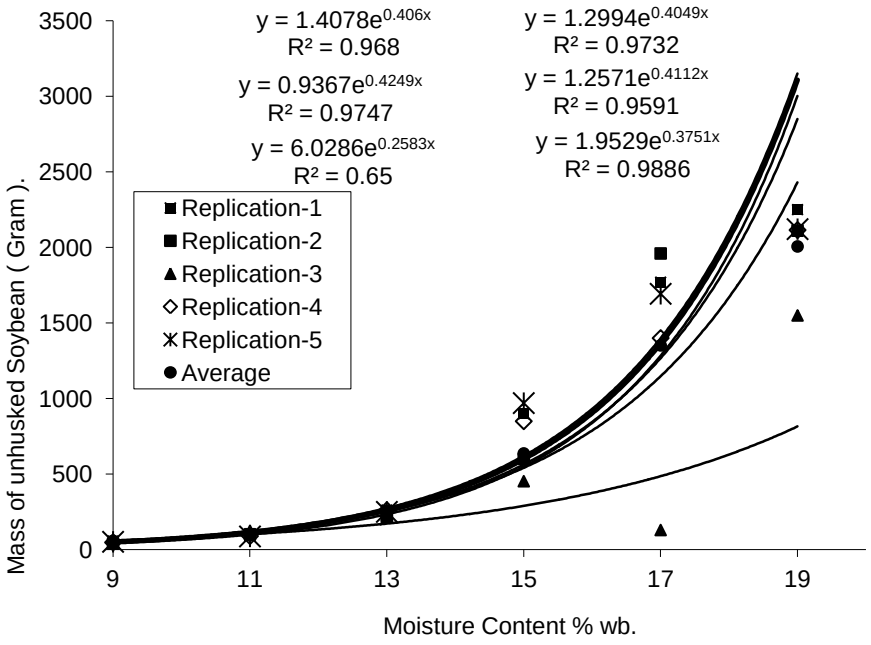

Fig. 3 : Variation in unhusked Soybean with Moisture Content % wb.