

Effect of storage and heating on good mature and green immature soybean and soybean dehulling

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RESUMEN

Efecto del almacenamiento y calentamiento en soja madura e inmadura y en el descascarado de soja.

Soja madura e inmadura se almacenó durante seis meses. Mensualmente, la soja fue analizada por su contenido en aceite, porcentaje de humedad, índice de acidez, índice de peróxido, análisis de ácidos grasos y, proteína y actividad ureásica en la harina de soja. Además, las muestras de soja se calentaron a diferentes temperaturas y tiempos, estudiándose el efecto del calentamiento sobre el descascarado. Finalmente, se construyeron y discutieron gráficas controles de índices de acidez y peróxido.

PALABRAS-CLAVE: Almacenamiento - Calentamiento - Descascarado - Soja inmadura - Soja madura.

SUMMARY

Effect of storage and heating on good mature and green immature soybean and soybean dehulling.

Mature and immature soybeans were stored for 6 months. Every month, soybeans were analysed for oil content, moisture percentage, acid value, peroxide value, fatty acid analysis, meal protein and urease activity in soybean meal. In addition, soybean samples were heated to different temperatures and times and the effect of heating on dehulling was studied. Finally, control charts of acid and peroxide values were constructed and discussed.

KEY-WORDS: Dehulling - Heating - Immature soybean - Mature soybean - Storage.

1. INTRODUCTION

High humidity is a major problem for soybeans with high temperatures, these conditions are conducive to mould growth on soybeans. Prolonged wet and dry weather has damaged large quantity of soybeans. When the damaged soybeans were placed in storage at high moisture levels, the damaged become progressively more severe. The recommended soybean moisture for harvest is 13% (1, 9, 10, 11, 14), however, in actual practice, soybeans are harvested between 13-18% (12). Soybeans harvested at higher moisture levels should

be dried to 13% or less for storage (2, 3, 12). When soybeans are stored for about 2 years, a moisture of 12% is recommended to maintain a good seed grade. The effect of dehulling methods on the composition of oil and water absorption, emulsification and foaming properties of the flour was investigated (6).

Wherever practicable, oilseeds are preferably decorticated before they are extracted. The hulls of oil-bearing seeds are low in oil content, usually containing not more than about 1%, although contamination with kernels will, of course, increase the oil content with resultant loss of available oil. If the hulls are not removed from the seeds before the latter are extracted, they reduced the total yield of oil by absorbing and retaining oil in the cake and, in addition, reduce the capacity of extraction equipment. Wet seeds are difficult to split cleanly and may clog the huller, particularly if it is of the disc type. On the other hand, if the seeds are very dry, the kernels may break excessively. The amount of hull recovered increased with decrease in moisture content (8). This study is a trial to get a process for lowering the adherence of soybean kernels to the hull rising the efficiency of dehulling process and achieving high quantity of the total yield of oil.

2. MATERIALS AND METHODS

Locally produced soybeans that had been stored in open air in the factory of Damanhour for 6 months were supplied by the factory. Soybeans under investigation were of both good quality (mature) and green beans (immature). The immature beans were picked up from soybeans supplied by the factory. Samples were taken monthly for determination of oil content with high quality n-hexane, moisture percentage, acid value, peroxide value, fatty acid analysis, meal protein and urease activity in soybean meal. The ratio of immature beans to mature soy was about 1 to 10 respectively.

Methods of analysis were made according to AOCS (4). The percentage nitrogen was determined

by semi micro Kjeldahl procedure and total protein was calculated as «Total nitrogen x 6.25» (12).

Soybean samples were heated in an oven before dehulling. Heating times were 60, 120 and 180 minutes. Soybean samples were heated at temperatures of 50, 60 and 70° C. Finally the soy dehulled manually and the hull percentage was calculated as:

$$\frac{\text{wt. of beans after dehulling}}{\text{wt. of beans before dehulling}} \times 100.$$

Statistical evaluation of the results using control chart was done.

3. RESULTS AND DISCUSSION

The effect of storage on good quality soybeans shown in Table I. It is clear that the oil content of the six samples ranges from 20.1 to 24.0 and this means that there is a little bit differences. During storage the peroxide value of produced oil increased through the 6 months and achieved more than double value. Peroxide value is the effective process for increasing oxidation causing rancidity. The change in moisture percentage was due to the environmental conditions through winter and summer. This moisture content is in inverse proportion to oil content while it is proportional to protein content. Total protein was gradually decreased with time from 46.8 to 43.0 at the end of six months. This means that protein was subjected to degradation process, and then beans contents were affected. Urease activity was increased through storage and this indicates that meal has to be subjected to suitable conditions for inhibition of urease activity considering that protein is not going to char.

Table I
Effect of Storage on Good Quality Soybeans

Sample	Oil content	Moisture %	A.V.	P.V.	M.P.	U.P.
After one month	21.0	7.0	0.7	1.5	46.8	1.1
After 2 month	22.7	6.1	2.7	1.4	45.5	1.4
After 3 month	20.1	6.8	0.6	1.3	44.5	1.5
After 4 month	20.1	7.4	0.7	2.0	43.0	2.0
After 5 month	22.0	5.6	1.3	3.2	43.0	2.0
After 6 month	24.0	4.0	0.8	3.4	43.0	2.0

A.V. = Acid value
P.V. = Peroxide value
M.P. = Meal protein
U.P. = Urease protein

The mean percentage of oil extracted from green soybeans was 19.9% while that of good quality soybean was about 21.6%. The results concerning the effect of storage on green soybeans are tabulated in Table II. The oil content was gradually decreased from 20.5 to 18.6 through the period of storage with increasing of acid value from 1.7 to 3.0 indicating that hydrolysis had happened getting free fatty acids. The reader may notice that peroxide value and moisture percentage were slightly increased. Total protein was gradually increased and there was nearly no urease activity which means that no protein degradation.

Table II
Effect of Storage on Green Soybeans

Sample	Oil content	Moisture %	A.V.	P.V.	M.P.	U.P.
After one month	20.5	6.4	1.7	4.2	44.0	1.9
After 2 month	20.4	6.2	1.9	4.5	44.0	2.2
After 3 month	20.4	6.1	2.0	4.7	44.5	2.1
After 4 month	20.4	6.3	2.2	4.8	45.0	2.1
After 5 month	19.5	6.5	2.4	4.9	46.0	2.0
After 6 month	18.6	6.6	3.0	5.3	46.0	2.0

A.V. = Acid value
P.V. = Peroxide value
M.P. = Meal protein
U.P. = Urease protein

Concerning the analysis of variance of factorial experiments (13), for illustrating of simple effect, main effect and interaction between time factor and soybean characteristics of soybean oil (quality of soybean). The authors were going to show these effects in Figures 1-6. We may conclude that:

1. The value of the slope of the lines K_1 K_1 represents the simple effects of time factor (T) at lower level of K_1 (good soybean) are equal 3.0, 1.9, 1.3 and 2.9 for the effect of storage on oil content, peroxide value, oleic and linoleic acids of good soybean respectively.
2. The value of the slope of the lines K_2 K_2 represents the simple effect of time factor at upper level of K_2 (green soybean) for the effect of storage on oil content, peroxide value, oleic and linoleic acids of green soybean are 1.9, 1.1, zero, and 5.8, respectively.
3. The main effect of time (factor T) on kind of soybean (factor K) for the preceding articles are 0.6, 1.5, 0.7 and 1.5, respectively.
4. The absolute value of interaction between time and kind of soybean factors during the storage of soybean are 0.4, 0.7, 2.5 and 4.4 for peroxide value, oleic acid, oil content and

linoleic acid, respectively. It means that the content of linoleic acid in soybean is highly affected and the peroxide value is the least article affected by the time of storage of soybeans.

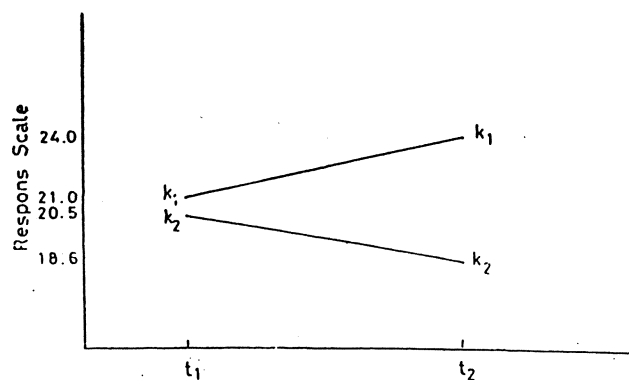


Figure 1
Effect of T factor (time) on K factor (kind of soybean)
for oil content

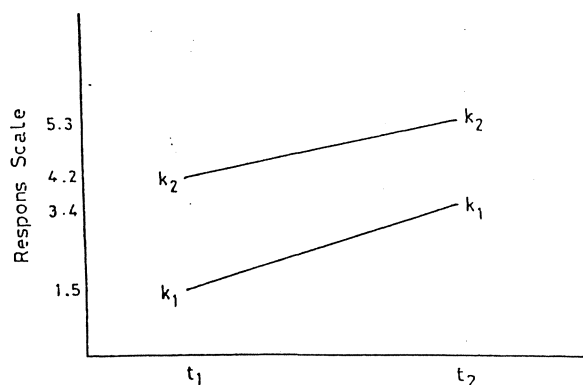


Figure 2
Effect of T factor on K factor for peroxide value

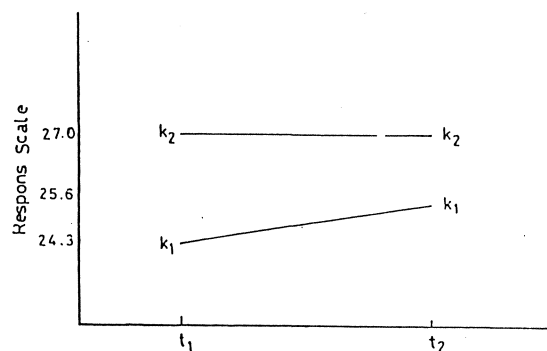


Figure 3
Effect of T factor on K factor for oleic acid percentage

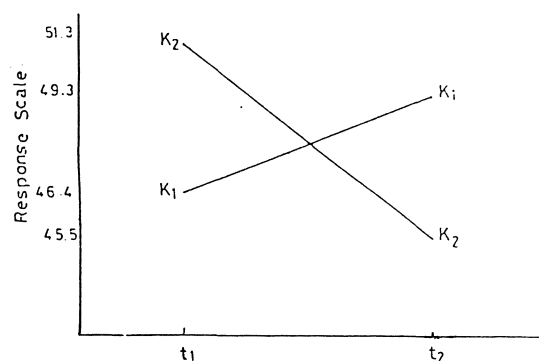


Figure 4
Effect of T factor on K factor for linoleic acid percentage

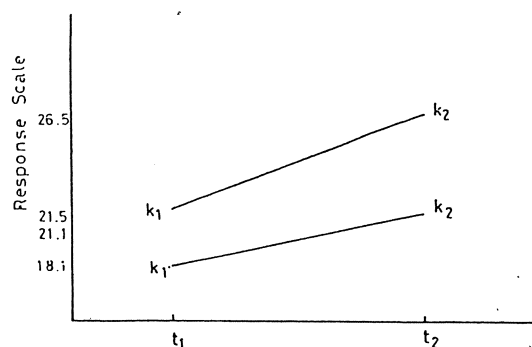


Figure 5
Effect of T factor on K factor for sot F.A. comp.

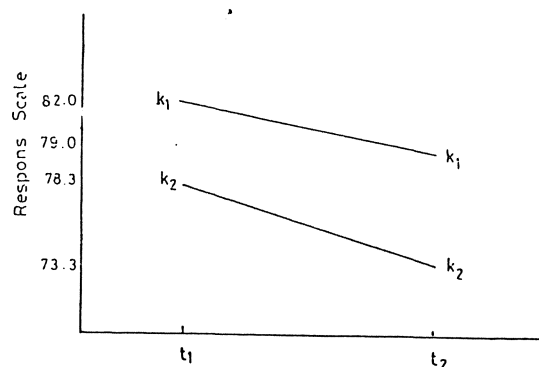


Figure 6
Effect of T factor on K factor for unsaturated F.A. comp.

From all the preceding results we may say that the time factor and quality of soybean are more or less dependent on each other during the storage of soybeans.

Regarding the effect of storage on fatty acid composition of green soybeans Table III we may trace that the percentage of short chain fatty acids were nearly higher comparing with good beans and this attribute to that fatty acid in green beans has not

formed yet. Lauric, stearic and linolenic acids were not detected, while palmitic, oleic, linoleic acids were present in higher percentage in green soybeans. This is attributable to the fact that green soybeans had not ripened yet.

Table III
Effect of Storage on Fatty Acid Compositions of Good Quality and Green Soybeans

Sample	C12:0		C14:0		C16:0		C18:0		C18:1		C18:2		C18:3	
	G.Q	G	G.Q	G	G.Q	G	G.Q	G	G.Q	G	G.Q	G	G.Q	G
After 1 month	1.2	—	2.1	2.3	11.8	19.4	2.0	—	24.3	27.0	46.4	51.3	12.2	—
After 2 month	1.5	—	2.2	3.5	10.7	19.4	1.4	—	24.2	26.7	47.0	50.3	13.0	—
After 3 month	1.9	—	2.4	4.0	13.7	21.8	3.0	—	25.0	26.2	48.0	48.0	7.0	—
After 4 month	1.9	—	2.5	3.8	15.7	22.8	2.5	—	23.0	27.3	48.8	46.0	5.5	—
After 5 month	1.1	—	2.9	4.9	12.7	22.0	2.0	—	26.4	28.0	49.0	45.0	5.8	—
After 6 month	1.3	—	2.7	4.3	13.8	23.1	2.0	—	25.6	27.0	49.3	45.5	5.3	—

G.Q = Good quality

G = Green bean

From results recorded in Figure 7 one can notice that hull percentage is going to be high using heating and the percentage goes higher with increasing time and temperature. Therefore, heating of soybean before grinding gives a rise in the efficiency of dehulling followed by a decrease in the loss of oil and also a decrease in the quantity of solvent used in extraction of oil.

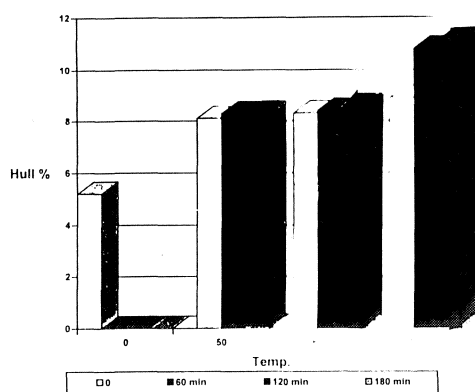


Figure 7
Effect of Heating on Soybean Dehulling

Control chart ($\bar{x}$ - chart) was constructed on the good quality soybean oil acid and peroxide values during storage of beans for 6 months. The results of this analysis are shown in Table I in which each value was a mean of 3 readings. The means, over all mean and the standard deviation were calculated and the chart was set up according to (5, 7). Using these two control charts, acid and peroxide values of green soybean oil samples shown in Table II were applied on the $\bar{x}$ - charts, Figures 8 and 9. You can trace that the means of acid values after the 4, 5 and 6 months climbed out of upper control limit while the means of the peroxide values of all months were out of control.

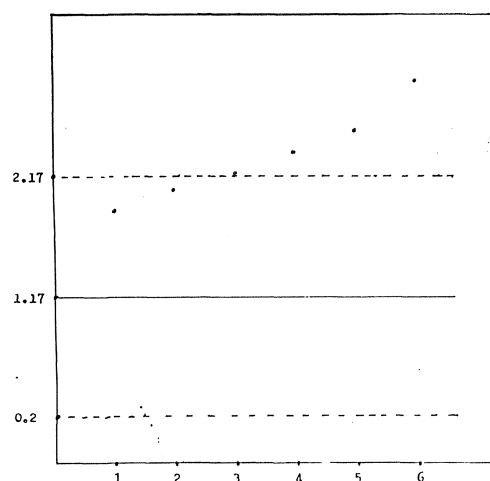


Figure 8
 $\bar{X}$ - Chart of acid value of green soybean oil during storage

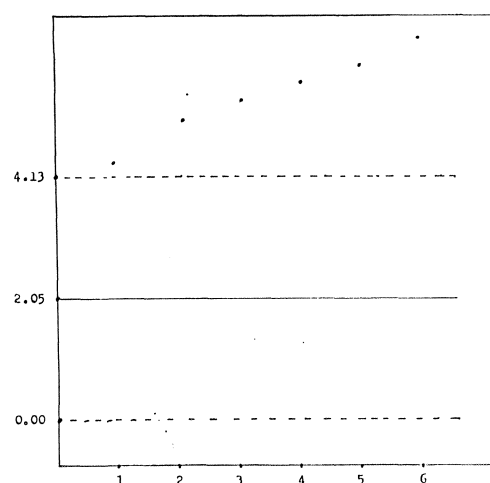


Figure 9
 $\bar{X}$ - Chart of peroxide value of green soybean oil during storage

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