Comunicación breve

Degumming of soybean oil

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RESUMEN

Desgomado de aceite de soja

El proceso de desgomado fue llevado a cabo en una fábrica de aceite crudo de soja en el departamento de aceites y grasas. Treinta y dos muestras fueron tratadas con concentraciones diferentes de ácido fosfórico y/o agua a temperaturas diferentes y con tiempo diferente de agitación. Se encontró que el desgomado de 100 g de aceite con solo 3,5% de agua y con 0,34 g de ácido fosfórico en 5,8% de agua a 75°C, con tiempo de agitación de 30 minutos, dio mejores resultados comparado con otras condiciones.

Se realizó el análisis de varianza de experiencias factoriales para ilustrar el diferente efecto y la interacción entre el tiempo de agitación y la temperatura, durante el proceso de desgomado.

PALABRAS-CLAVE: Aceite de soja - Análisis estadístico - Desgomado.

SUMMARY

Degumming of soybean oil

Degumming process was carried out on Factory grade crude soybean oil in fats and oils Department. Thirty two samples were treated with different concentrations of phosphoric acid and / or water at different temperatures and with different time of stirring. It was found that degumming 100 gm of oil with 3,5% water only and with 0,34 gm phosphoric acid in 5,8% water, at 75°C with stirring time of 30 minutes gave better results compared with other conditions.

The analysis of variance of factorial experiments for illustrating the different effect and interaction between time of stirring and temperature during degumming process was recorded.

KEY-WORD: Degumming - Soybean oil - Statistical analysis.

1. INTRODUCTION

The emphasis of our subject needs to be turned around and our objective stated as the removal of fat-soluble impurities present in crude soybean oil. The soluble impurities in crude soybean oil are identified as gums or sludge which consist of phospholipids and metal complexes, free fatty acid, peroxides and their breakdown products, and pigments. Gums and metal complexes are removed by degumming or chemical refining (1-6).

The purpose of water degumming is two folds. On the one hand, it is necessary to remove almost completely phosphatides or gums from the oil in order to produce a fully refined oil, and, on the other hand, gums may be valuable by-products. When water is added to a crude oil, most of the phosphatase in the oil are hydrated and made insoluble in the oil. This forms the principle for the water degumming process (7).

Many patents have appeared on improved methods to degum soybean oil by hydration Schonfeld (8) cited early patents on the use of calcium sulfate, sodium sulfate and boric, hydrochloric and tannic acids as degumming oil. Later patents, summarized by Norris (9), described as degumming oils the use of sodium chloride, phosphoric acid, alkaline, phosphates and polyphosphates in combination with neutralization, refining and bleaching citric acid (10) or acetic anhydride (11) have been applied as degumming oil. Non ionic, cationic and anionic surfactants have also been patented as degumming agents (12).

Degumming and refining were carried out by continueous process in some of the Egyptian factories using 3,5 kg phosphoric acid (85%) then 3,5 kg caustic soda per ton of oil at 75°C.

2. MATERIALS AND METHODS

Crude soybean oil was kindly available from Damanhour Factory, Degumming process was carried out in Fats and Oils Dept. Thirty two samples of crude soybean oil each sample weight was 100 gm. Each sample was treated with different concentrations of phosphoric acid, 85%, (0,086, 0,17 and 0,34 gms) in 3,5 or 5,8 ml of water or treated with water only (3,5 and 5,8 ml). The experiments were carried out at temperatures of 45 and 75°C and with different time of stirring (15 and 30 minutes) where the other conditions were constant. The results are shown in Tables I-IV

3. RESULTS AND DISCUSSION

It is apparent that some conditions of degumming step are considerably able to remove more gums than others.

Degumming of 100 gm of oil with 3,5% water only and with 0,34 gm phosphoric acid in 5,8% water at 75°C with stirring time of 30 minutes gave better results compared with other conditions.

It should be pointed out that conditions for commercial degumming may be dictated by factors other than those directed toward the most complete removal of phosphorous for example, processors who remove the lecithin must take into account the quality of crude gums. Higher temperatures may speed the operation and remove phos-

Table I
Degumming of oil* with stirring 15 minutes at 45°C**

Additive	Wt. of dried gums in grams
3,5% water only	2,1
0,086 gm phosphoric acid in 3,5% water	2,3
0,17 gm phosphoric acid in 3,5% water	2,2
0,34 gm phosphoric acid in 3,5% water	2,6
5,8% water only	2,3
0,086 gm phosphoric acid in 5,8% water	2,3
0,17 gm phosphoric acid in 5,8% water	1,5
0,34 gm phosphoric acid in 5,8% water	2,7

* In all experiments degumming process was carried out on 100 gm oil.
** Speed of stirrer was 250 rpm and it was constant through all experiments.

Table III
Degumming of oil with stirring 15 minutes at 75°C

Additive	Wt. of dried gums in grams
3,5% water only	2,4
0,086 gm phosphoric acid in 3,5% water	2,4
0,17 gm phosphoric acid in 3,5% water	2,5
0,34 gm phosphoric acid in 3,5% water	2,4
5,8% water only	2,6
0,086 gm phosphoric acid in 5,8% water	2,5
0,17 gm phosphoric acid in 5,8% water	2,8
0,34 gm phosphoric acid in 5,8% water	2,4

phorous, but at the same time the lecithin may be degraded and darkened by the more drastic degumming conditions. Thus, while a higher degree of phosphatide removal is desirable, a lighter high quality lecithin may be obtained at the expense of higher phosphatide removal (13).

Applying the analysis of variance of factorial experiments according to Steel and Torrie (14) for illustrating of simple effects, main effects and interaction between time of stirring factor (T) at t_1 and t_2 which indicate 15 and 30 minutes of stirring respectively and temperature factor (C) at c_1 and c_2 which represent 45 and 75°C respectively. The speed of stirring and volume of solution were constant through the all experiments.

These effects of T on C factors and vice versa determined during the degumming of oil process using water only and water phosphoric acid mixture. The effects of factors are shown in figures 1-4.

Figures 1 and 3 explain that: (1) the value of the slope of the two lines t_1t_1 represent the simple effects of C factor (temperature) at lower level of t_1 (15 minutes stirring) for the degumming of oil using water only and water-phosphoric acid mixture and are equal 0,9 and 0,3 respectively. (11) The slope of the 2 lines (t_2t_2) represent the simple effect of temperature factor (C) at upper level of time of stirring (t_2) which represents 30 minute stirring equal 1,1 and 0,6 respectively, and (111) The main effects of temperature on time of stirring equal 0,9 and 0,5 in case of using water only and water - phosphoric acid mixture, respectively.

Figures 2 and 4 show that (1) the value of the slope of the lines (c_1c_1) and (c_2c_2) which represent the simple effects of stirring time (T factor) at lower and upper levels of c_1 and c_2 which indicate 15 and 30 minutes of stirring

Table II
Degumming of oil with stirring 30 minutes at 45°C

Additive	Wt. of dried gums in grams
3,5% water only	3,0
0,086 gm phosphoric acid in 3,5% water	2,5
0,17 gm phosphoric acid in 3,5% water	2,0
0,34 gm phosphoric acid in 3,5% water	2,8
5,8% water only	3,2
0,086 gm phosphoric acid in 5,8% water	2,4
0,17 gm phosphoric acid in 5,8% water	2,3
0,34 gm phosphoric acid in 5,8% water	3,0

Table IV
Degumming of oil with stirring 30 minutes at 75°C

Additive	Wt. of dried gums in grams
3,5% water only	3,5
0,086 gm phosphoric acid in 3,5% water	3,0
0,17 gm phosphoric acid in 3,5% water	2,8
0,34 gm phosphoric acid in 3,5% water	3,0
5,8% water only	3,7
0,086 gm phosphoric acid in 5,8% water	3,2
0,17 gm phosphoric acid in 5,8% water	3,0
0,34 gm phosphoric acid in 5,8% water	3,2

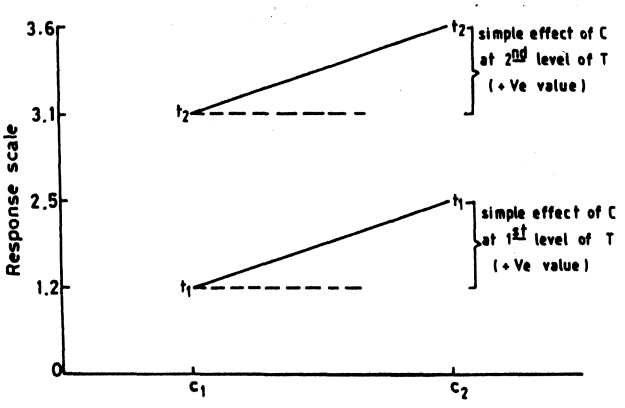

Figure 1
The effect of C factor (temperature) on T factor (time of stirring) for the degumming of oil using water only.

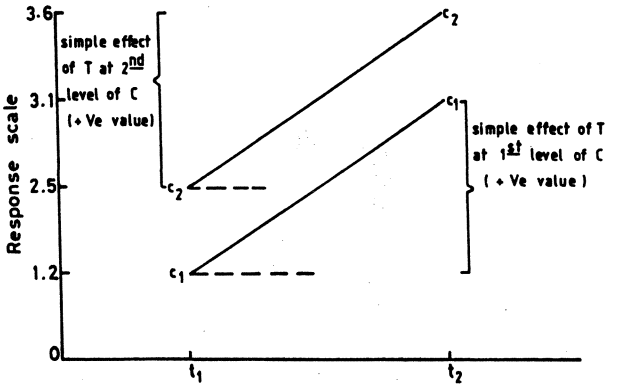

Figure 2
The effect of T factor (time of stirring) on C factor (temperature) for the degumming of oil using water only.

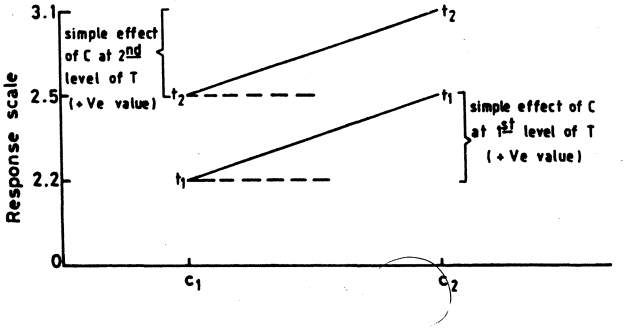

Figure 3
The effect of C factor (temperature) on T factor (time of stirring) for the degumming of oil using water - Phosphoric acid mixture.

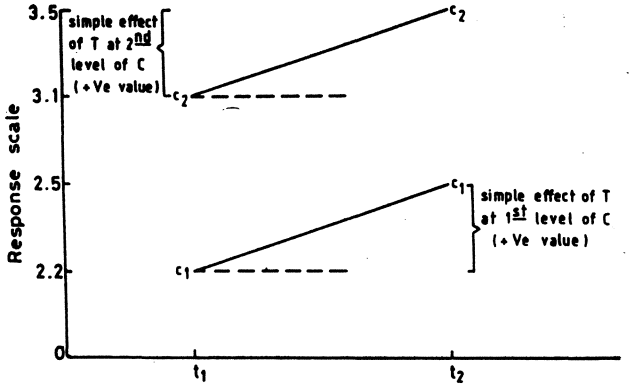

Figure 4
The effect of T factor (time of stirring) on C factor (temperature) for the degumming of oil using water - Phosphoric acid mixture.

respectively equal 1,3 and 0,3 for c_1c_1 and 0,5 and 0,6 for c_2c_2 in case of degumming of oil using water only and water phosphoric acid mixture, respectively. (11) The main effects of stirring time on temperature equal 1,0 and 0,5 for water only and water - phosphoric acid degumming, respectively. The absolute value of the interaction equal 0,4 and 0,05 for water only and water - phosphoric acid degumming respectively.

Concerning just the weight of gums, one can conclude that degumming of oil using water only is much better than that of water - phosphoric acid mixture.

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(Recibido: Junio 1991)