THE QUESTION OF THE PRODUCTION OF PLANTAGLYUTSID

A. M. Khagi and K. A. Sabirov

UDC: 615.014:542.61:582.962

The stage of extracting Plantaglyutsid from the leaves of rippleseed platain has been optimized by the methods of mathematical statistics. Information has been obtained on the optimum parameters of performing the process, as a result of which the yield of desired product has been increased and the amount of energy used and the consumption of extractant have been decreased.

The extraction of the leaves of Plantago major L. (rippleseed plantain) in the production of Plantaglyutsid is done with hot water at a pressure of 29.0-68.6 kPa with periodic stirring for 1 h followed by steeping for 2 hours. The first extract is made in a ratio of 1:8 and the second in a ratio of 1:6; the process is performed similarly with a steeping time of 1 h. The method has certain disadvantages: the length of the extraction process, the high consumption of extractant, and the large volumes of solutions to be evaporated in the following stage.

In order to develop a rational method for extracting the active substances from the leaves of rippleseed plantain we propose to use battery countercurrent extraction, which will permit the maximum amount of active substances to be extracted from the raw material and the consumption of extractant and of energy in the process to be decreased.

To develop the method, the main factors of the process, selected on the basis of preliminary experiments, were studied: X_1 – the number of extractors in the battery; X_2 – the time of contact of the phases; X_3 – the time of evaporation of the raw material X_4 – the liquid ratio of the process; and X_5 – the temperature of the process. As the optimization criterion we selected the yield of Plantaglyutsid, Y, g.

For the experiments we used a battery of extractors each with a capacity of 10 liters forming a model of the apparatuses working in the scheme for the production of Plantaglyutsid. The laboratory reactor was fitted with a jacket, a stirrer, and a perforated false bottom and enabled all the above-mentioned factors to be varied. The working charge was 0.5 kg of rippleseed plantain leaves.

EXPERIMENTAL

To optimize the process we used the Box-Wilson method for the mathematical planning of experimental work. We used a fractional factorial experiment of the 2^{5-2} type [1]. The planning matrix, the levels of the factors, and the intervals of their variation, the steps of the steepest ascent, the response function, and also the results of the statistical treatment of the results and the corresponding regression equations are given in Table 1.

The results of the experiments were presented in the form of the regression equation

$$Y = 56.43 + 0.45X_1 + 0.50X_2 + 0 \cdot X_3 + 0.25X_4 + 0.05X_5 + 0.05X_1X_3 - 0.1\,X_2X_3.$$

The significance of the regression coefficients was evaluated by the Student-Fisher criterion. It follows from a comparison of the values of the confidence interval B with the regression coefficients that factors X_1 and X_2 are significant in this equation. In the equation, these factors have coefficients with a positive sign, which indicates the necessity for intensifying them in the performance of the steepest ascent.

To confirm the adequacy of the equation to the true response surface, Fischer's F criterion was calculated and compared with tabular values of it. As follows from the table, $F_c < F_t$, which permits the equation obtained to be regarded as adequate to the real process

Tahskent Pharmaceutical Institute. Translated from Khimiya Prirodnykh Soedinenii, No. 6, pp. 735-737, November-December, 1985. Original article submitted December 18, 1984.

0009-3130/85/2106-0691$09.50

TABLE 1. Planning, Results, and Statistical Treatment of the Experiments

Experiment no.	Experiment-planning matrix								Response function				Levels of the factors and intervals of their variation					
	X_0	X_1	X_2	X_3	X_4	X_5	X_1X_2	X_2X_3	Y_1	Y_2	$\bar{Y}$	$\hat{Y}$	Level	X_1, min	X_2, min	X_3, min	X_4, liters/kg	X_5, °C
1	+	−	−	+	+	−	−	−	55,5	55,7	55,6	55,58	Base level	3	20	5	10	90
2	+	−	+	−	+	+	+	−	56,6	57,0	56 8	56,78	Interval of variation	1	10	5	2	10
3	+	+	+	−	−	−	−	−	56,9	57,1	57,0	57,08						
4	+	+	−	+		+	+	−	55,9	56 5	56 2	56,18	Upper level	4	30	10	12	100
5	+	+	−	−	+	+	−	+	56,2	56,6	56,4	56,68						
6	+	−	−	−	−		+	+	54,7	55,3	55,0	55,18						
7	+	−	+	+	−	+	−	+	55,6	56,4	56,0	56,28	Lower level	2	10	0	8	80
8	+	+	+	+	+	−	+	+	57,1	57,7	57,4	57,58	Steepest ascent step	—	5	—	—	—

Results of the Statistical Treatment of the Data

$S^2\{Y\}=0,135$	$S^2\{B_i\}=0,017$	$S^2_{max}=0.32$	$G_c=0,296$	$G_t=0,3043$	"B"=0,31	$S^2_R=0,115$	$S_R=0,229$	$F_c=0,11$	$F_t=4,46$	$\sum S_i^2=1,08$

and enables a steepest ascent to be performed over the response surface. The results of the experiments according to the steepest-ascent program and the conditions of their performance are given below. It was decided not to perform a steepest ascent with respect to the factor X_1 and this factor was fixed at its upper level, i.e., $X_1 = 4$; it is undesirable to use a battery with a larger number of extractors under industrial conditions:

Experiment no.	Conditions of performing the experiment					Yield	
	X_1	X_2	X_3	X_4	X_5	$\bar{Y}$	$\hat{Y}$
1	4	20	5	10	90	58,60	56,43
2	4	30	5	10	90	60,10	57,43
3	4	40	5	10	90	62,00	58,43
4	4	50	5	10	90	61,80	58,12

The optimum regime of the process of extracting rippleseed plantain leaves was achieved in the third experiment. The product obtained corresponded to the demands of the standardization and technical documentation [2].

SUMMARY

Optimization by the method of mathematical statistics of the stage of extracting rippleseed plantain in the production of Plantaglyutsid has revealed rational conditions for performing the process, consisting in the countercurrent extraction of the raw material in hot water in a battery of four extractors at a ratio of 1:10 and a temperature of 90°C, with the preliminary 5-min boiling of the raw material with live steam and with a time of contact of the phases of 40 min with periodic stirring. Under these conditions, the yield of Plantaglyutsid increased by an average of 5% and the consumption of extractant and of energy decreased.

LITERATURE CITED

1. V. V. Nalimov and N. A. Chernova, Statistical Methods for Planning Extremal Experiments [in Russian], Moscow (1965), p. 37.
2. FS 42-1815-82 "Plantaglyutsid."