REGRESSION ANALYSIS OF CARTHAMIN EXTRACTION FROM SAFFLOWER (CÁRTHAMUS TINCTÓRIUS)

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Abstract: Effects of ethanol and moderate quantities of citric acid on the extraction of Safflower dyes were investigated. Complete two-factor experiment in linear approximation was used. A negative effect of the addition of citric acid on the extraction efficiency was detected. It is shown that the direct influence of ethanol on the extraction of Safflower dyes is insignificant (which generally is unusual for organic substances). It means, that carthamin and other water-soluble components extracted from Safflower, have a high potential for safety use in the food industry.

Keywords: safflower, carthamin, extraction, ethanol, citric acid, regression analysis

Introduction

Safflower is inhabitant of arid region and represents an herbaceous plant with sharply expressed external properties. Carthamin is natural pigment, obtained from petals of Safflower. This water-soluble pigment known as Natural Red 26, is traditionally used as a dye for hair and tissues. Cartamine molecule is composed from two chalcon residues, which conjugated bonds causes manifestation of red color.

Materials and methods

In standard chemical glass tubes were added 0.2 grams of Safflower petals, rectified ethanol, aqueous solution of citric acid and distilled water (Table 1).

Table 1. *Planning matrix of experiment "The influence of factors on the extraction of Safflower dyes" in encoded and real coordinates.*

Sample	Ethanol, X_1, mL		H₃Cit 1%, X_2, mL		X_{12}	Water, mL	Σ, mL
1	+	6.0	+	3.0	+	1.0	
2	+	6.0	-	1.0	-	3.0	10
3	-	2.0	+	3.0	-	5.0	
4	-	2.0	-	1.0	+	7.0	

UV – Spectra of extracts were registered at DR-5000 spectrophotometer in range of 200…800nm, using 1cm polystyrene curves.

Results and discussion

Was elaborated mathematical procedure, allowing to calculate parameters of the regression equation in express mode according to the plan of a complete two-level two-factor experiment, (CFE 2^2), as well as a two-level three-factor fractional experiment (FFE 2^{3-1}). The procedure uses standard Excel functions and allows to calculate the average value, dispersion of average value, dispersion over all matrix and dispersion of regression coefficients. It is possible to use any level of significance, **P**. We allowed a "world-wide" level of **P** = 95%, q = 5%. Hand-made soft also offer possibility to calculate the corresponding values of Student's coefficients, regression coefficients and beta-critical.

Figure 1. *Fragment of the Excel desktop for calculation of regression coefficients of equations according to CFE 2^2 and FFE 2^{3-1} plans.*

As a result, a regression equation for absorbance in the absorption maximum of spectra, at 540nm, was deduced:

$$A_{540nm} = 0.595 + 0.005X_1 - 0.065X_2 + 0.025X_{12} \qquad (1)$$

$$\beta_{critical} < 0.010 \text{ (estimated)}$$

The regression equation shows, that the influence of ethanol has positive, but very insignificant value ($\beta_1 = + 0.005$). Citric acid ($\beta_2 = - 0.065$), opposite, demonstrate a significant negative effect on the extraction of carthamine from Safflower petals. The factor of ethanol and citric acid interaction is positive and from our point of view, is significant ($\beta_{12} = + 0.025$). But at the same time it does not overlap direct negative influence of citric acid, so, this factor finally is not important for extraction of carthamine in the investigated conditions.

Conclusion: The specificity of the extraction of food dyes from Safflower is, that traditionally used ethanol and citric acid do not increase the yield of the dye, therefore, their use is impractical. This feature increases the value of dyes from Safflower, because the exclusion of alcohol and citric acid from the dye extraction process reduces the hazards of production and increases the safety of the dyed food product.

References

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