

Integrated process for recovery of alkaloids from yellow horn poppy

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Abstract: The recovery of aporphine alkaloids from yellow horn poppy was studied. For this, solid-liquid extraction was coupled with pertraction. The alkaloids were transferred from the initial source material into the final receiving solution via the obtained native extracts of the plant and the organic liquid membrane. The applied integrated extraction-pertraction process showed to be very simple, rapid and efficient.

Keywords: alkaloids; extraction; pertraction; integrated process

INTRODUCTION

The plant yellow horn poppy is rich in aporphine alkaloids and their main representative is glaucine. The latter is used in the production of drugs because of its strong antitusive [7], analgesic [9], antibacterial [6] and anti-inflammatory [4] properties.

Alkaloids are commonly derived from raw plants by extraction. The obtained extracts usually contain co-extracted species, so additional purification is needed in order selectively to recover the alkaloids. For this purpose solvent extraction is mainly applied [1], but liquid membrane processes have shown lately to be an adequate alternative to it. For example, rutaecarpine was extracted from *E. rutaecarpa* var. *officinalis* extracts using bulk liquid membranes [8] and vincamine was recovered from *Vinca minor* L. extracts by pertraction technique [3]. When applying a liquid membrane process, both extraction and stripping processes are simultaneously and continuously performed in one apparatus. In this way the target specie could be completely recovered, whereas by conventional solvent extraction this is only possible with multiple extraction-stripping operations [5].

An integrated process based on extraction of valuable species from vegetal sources and their simultaneous liquid membrane purification has already been proposed [2]. In this work solid-liquid extraction was coupled with pertraction technique to recover and simultaneously isolate alkaloids from yellow horn poppy.

MATERIALS AND METHODS

The aerial part of yellow horn poppy, grown in the region of Burgas was used ground and homogenized.

Standard glaucine hydrobromide (>97%) was kindly supplied by the Institute of Organic Chemistry, Sofia.

The organic solvents *n*-heptane (Reachim, Russia), the phosphoric acid (Fluka) and the dipotassium hydrogen phosphate (Sigma-Aldrich) used for pH-adjustment of the aqueous solution, as well as the acetonitrile (Labsan) and potassium dihydrogen phosphate (Sigma-Aldrich) used in the HPLC analysis were all of AR grade.

The amount of aporphine alkaloids in the aqueous solutions was measured by a HPLC system, consisting of an UV-detector "Knauer", an integrator C-R6A Chromatopack "Shimadzu" and a reverse phase column C18 Nucleosil 100-5. The mobile phase used was a 74:26 (v/v) mixture of 0.03 M KH₂PO₄ and CH₃CN. The flow rate was 1 cm³min⁻¹. The alkaloids amount in the organic solution was obtained from the mass balance.

The amount of all species dissolved in the initial and final aqueous solutions was determined after solvent evaporation and the alkaloids percentage in the extracts was obtained.

Hydrogen ion concentration in the aqueous solutions was measured by a digital pH meter OP-211/1 (Radelkis, Hungary) equipped with a combined electrode.

EQUIPMENT AND PROCEDURE

Solid-liquid extraction of alkaloids from yellow horn poppy was combined with simultaneous pertraction in an integrated process. The experimental set-up is schematically shown in Fig. 1.

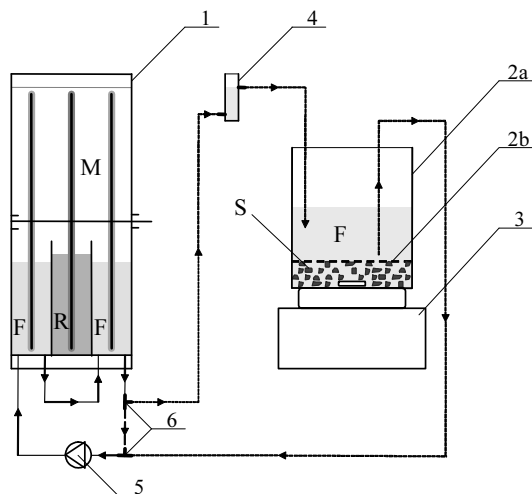


Fig. 1. Experimental set-up: 1 - pertractor; 2a - extractor; 2b - fine grid; 3 - magnetic stirrer; 4 - overflow drain; 5 - peristaltic pump; 6 - three way valves.

6.5 g of grounded dry herb (solid phase S) was put in the extractor (2a) and approximately 360 cm³ of buffered aqueous solution with pH 9 were added. The obtained suspension was homogenized by a magnetic stirrer (3). The extractor was coupled with the feed solution compartments of the pertractor and the obtained native liquid extract recirculated by means of a pump (5) in a closed loop throughout both devices. Solid particles were kept in the lower part of the extractor by a fine grid (2b).

The bottom part of the pertraction device consisted of three separated compartments. In each of them there was a hydrophilic rotating disc. The feed (F) – the native aqueous solution (pH 9; volume 290 cm³) from the extractor filled the outer compartments, and the receiving phase (R) – an aqueous solution of H₃PO₄ (pH 2; volume 145 cm³) was poured into the middle compartment. The upper part of the pertraction device was filled with 1050 cm³ organic liquid (M), which covered both aqueous solutions. During rotation the discs immersed alternately in the corresponding aqueous solution and in the organic liquid and in this way mass transport of the alkaloids was achieved.

RESULTS AND DISCUSSION

Alkaloids extraction from yellow horn poppy was coupled with pertraction in order to implement an integrated process for alkaloids recovery. The native liquid extract obtained in the extractor was led into the pertraction device as feed solution. This solution circulated constantly and consecutively through both devices, thus, both extraction and pertraction were carried out simultaneously. The appropriate conditions at the three interfaces provided continuously the necessary process driving force which allowed efficient mass transfer of alkaloids from the solid phase into the receiving solution.

The kinetics of the alkaloids transport throughout the integrated process is represented in Fig. 2.

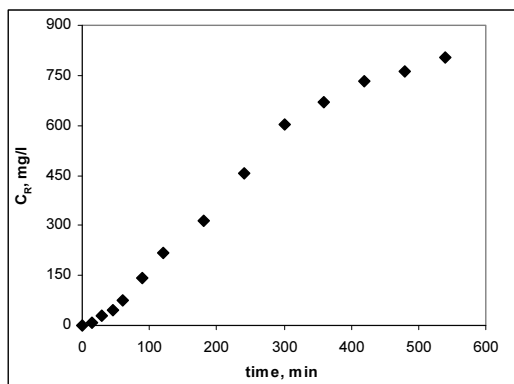


Fig. 2. Alkaloids accumulation in the receiving solution during the integrated process

After an initial period of 30 minutes, steady state was reached and the rate of alkaloids accumulation in the receiving solution was relatively constant until the 5th hour, when the rate of accumulation started to decrease because of the exhaustion of the vegetal source. After 9 hours more than 95 % of the alkaloids were extracted and transferred into the receiving solution. The plant material was practically exhausted. The alkaloids repartition between the four phases at the end of the integrated process is given in Table 1.

Table 1. Repartition of the alkaloids in all four phases at the end of the integrated extraction-pertraction process (after 9 h).

Phase	Content of alkaloids [%]
Solid phase	0.21
Feed phase	1.33
Liquid phase	1.91
Receiving phase	96.55

CONCLUSIONS

Alkaloids could be selectively recovered and isolated by applying an integrated extraction-pertraction process. Coupling of solid-liquid extraction of aporphine alkaloids from yellow horn poppy with simultaneous purification of the obtained native extracts by pertraction provided a simple and efficient way to obtain products of high purity. After 9 hours of integrated extraction-pertraction process, 99.8 % of the alkaloids were extracted from the source material and 96.5 % were already transferred into the receiving solution.

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Докладът е рецензиран