

Analysis of selected poppy (*Papaver somniferum* L.) cultivars: Pharmaceutically important alkaloids

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ABSTRACT

The content of pharmaceutically important alkaloids (morphine, codeine, thebaine, papaverine and narcotine) was analysed in the empty poppy capsules (poppy straw) of fifteen selected cultivars of *Papaver somniferum*. By applying the cluster analysis and *k*-means methods, four clusters representing the sets of cultivars with a defined level of production of the selected alkaloids were determined, based on their similarities.

The content of individual minor alkaloids, which was obtained was relatively low (0.00–0.17%) and in some cases negligible, defined by the dominant representation of morphine in the alkaloid spectrum of all selected cultivars. In addition to the high-morphine cultivar 'Buddha' (mean 1.64%), there was a middle content (mean 0.79%) or low content (mean 0.61%) of morphine in the cultivars included in clusters 2 and 3 (average of 3 consecutive years 2007, 2008 and 2009). A relatively high content of morphine was detected in cultivar 'Böhmův bělosemenný' (mean 0.91%), although it is usually published that white-seed cultivars contain less morphine and other alkaloids, compared to blue-seed or grey-seed cultivars. Low content of morphine (mean 0.48% resp. 0.44%) by relatively high content of narcotine (mean 0.11% resp. 0.15%) was obtained in poppy cultivars 'Danneborg' and 'Tatarstan'. Also, surprisingly the highest papaverine content (mean 0.07%) was detected in the cultivar 'Sušický červenosemenný' with the lowest content of morphine (mean 0.34%).

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1. Introduction

The genus *Papaver* L. includes about 100 species taxa, of which about 80 have been previously analysed for the composition of the alkaloid spectrum, with isolation of approximately 140 alkaloids. The alkaloids found in these plants belong to the isoquinoline and biogenetically derived variants. *Papaver somniferum* L. generally accumulates the most morphine, usually comprising 45–90% alkaloid content, although the representation of other alkaloids is generally low.

Marculescu and Bobit (2001) studied the dynamics of alkaloid genesis during growth and development of the capsule. Rarely, were cultivars with a dominance of thebaine, codeine, papaverine and narcotine obtained. In terms of cost-effective collection of poppy straw for the isolation of morphine, the limiting factor is the cultivar with a genetic fixation of alkaloid production, primarily climatic conditions of the year, cultivation technologies including fertilization, application of morphoregulators and fungicides, seed treatment and harvest are of a lesser influence. The influence of

stress is significant (Lachman et al., 2006; Mahdavi-Damghani et al., 2010).

Morfinan alkaloids arise from the intermediate product of norlaudanosoline; in the transcription of its chemical constitution, the isoquinoline nucleus rotates around the axis. Norlaudanosoline methylates with the formation of reticuline, which passes to promorphinan alkaloid salutaridine. The subsequent reactions generate thebaine (Balazova and Psenak, 1998), which pass to neopinone and codeinone in codeine, from which morphine originates via demethylation. Thebaine and salutaridine are located in more species of the genus *Papaver* L., for example, findings were previously reported of thebaine in *P. oreophilum* RUPR., *P. pilosum* SIBTH. et SMITH or *P. fugax* POIR. The presence of thebaine in *P. bracteatum* LINDL. is considered prospectively important as a dominant alkaloid with potential application in the pharmaceutical industry. Phenolic oxidation leading to the formation of thebaine is therefore a more general phenomenon in poppy plants. But only taxa *P. somniferum* L. and *Papaver setigerum* DC. have the specific ability of demethylation of methoxyl groups of the A and D circle, resulting in the milder painkiller codeine and the strong narcotic morphine. The second path leads through oripavine (Fig. 1).

These phytochemical properties were one of the main reasons for establishing a new section *Glauca* J. NOV. et V. PREIN.

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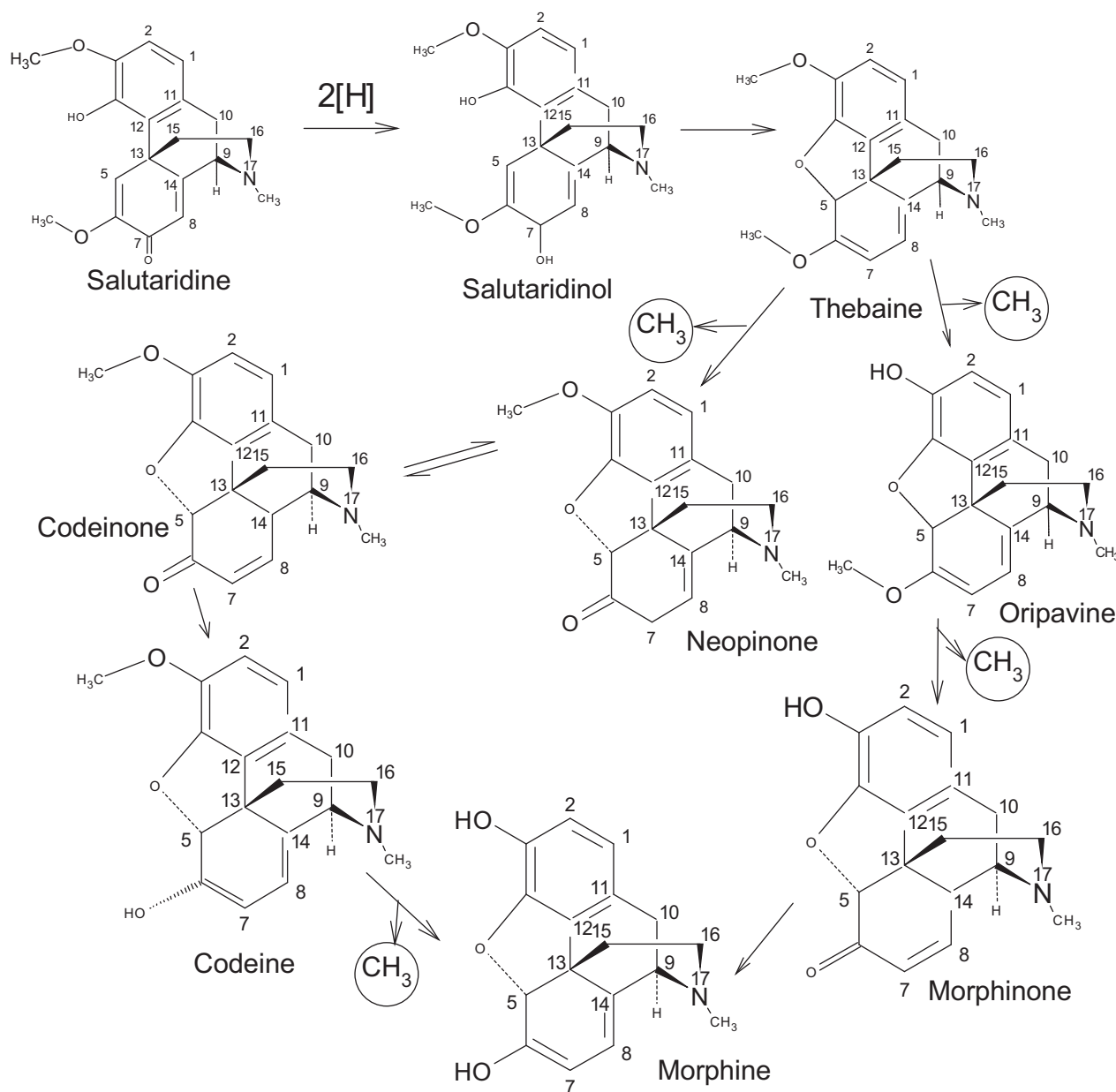


Fig. 1. Biosynthetic paths of morphine formation.

Modified by Balazova and Psenak (1998).

of the genus *Papaver* L. (Preininger et al., 1981). Breeding the poppy is currently focused either on the range and quantity of alkaloids, especially morphine contained in the capsule (industrial types), or on the yield and colour of the seed (food types). Concerning the morphological and planting traits and increase of production of morphine, includes the prospect of genetic analysis (Kumar and Patra, 2010) and the study of heterosis (Kumar et al., 2008).

2. Materials and methods

The aim of this study is to determine the content of five main alkaloids in the poppy capsules of selected agro-technically interesting cultivars having various coloured seeds for the purposes of the renewal of poppy breeding with a view to its further usage.

2.1. Plant material and design

Seeds of 15 cultivars of *P. somniferum* L. were provided by the gene bank of the Research Institute of Oilseed (Opava, Czech Republic), including currently cultivated as well as older cultivars (Table 1).

Thus, a total of 15 treatments (selected cultivars, Table 1) were raised in a randomized block design with 3 replications at the experimental land of the Czech University of Life Sciences Prague (CULS Prague), Czech Republic, during three consecutive years 2007, 2008 and 2009.

The planting was done in 3-m long rows with row-to-row and plant-to-plant distances of 25 and 12.5 cm, respectively (manual seeding at the depth of 0.5 cm in the period from 4th to 14th April, singling in stages 3 and 4 of the right leaves). Each cultivar was represented by 4 rows (as experimental rows) and 2 rows as

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