

# The story of the Macedonian “Black gold” – opium poppy (*Papaver somniferum*)

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## History of poppy cultivation

A detailed study on poppy cultivation in Macedonia from a socio-economic aspect was conducted by Jovanovic (2009). The first poppy was planted in Macedonia in 1835 in the vicinity of Shtip, probably introduced from Afyon province of Turkey (Brunetti, 1951) when Macedonia was part of the Ottoman Empire. Farmers quickly adopted this new crop (local name Afion), collecting semi-dried opium from incised unripe capsules. Towards the end of the 19th century, 28% of the Ottoman Empire's total output of opium was cultivated in Macedonia. The first statistical data refers to 70 tons of raw opium produced in the valley of the river Vardar in 1880.

Macedonian poppy had the highest raw morphine content in the world, ranging between 14 to 16%, (by comparison China poppy had 3-5%). Poppy was produced in 40 municipalities, but the highest percentage of morphine was obtained in the area of Kavadarci, Strumica and Veles. In 1927 Macedonia was providing 95% of the production in former Yugoslavia, which was satisfying 43% of the needs of all legal processing factories globally in the period between the two World Wars. In the following years, yields decreased due to unfavorable climate conditions, and increases in pests and diseases. In addition, opium prices dropped significantly in 1930-31, which resulted in a decreased area sown from 14,110 hectares in 1930 to 4,009 hectares in 1932. Consequently, farmers returned faith in poppy cultivation rather slowly.

The quality of the Macedonian poppy, also known locally as “black gold”, was a crucial factor in founding of the Pharmaceutical Company ‘Alkaloid’ in 1936 (Alkaloid, 2016). In the post-war period, Macedonia remained the sole Yugoslav republic producing opium poppy. The severe yield loss in 1949, due to bad climate conditions and high prices of other crops, contributed to decreased poppy production which had been retained on approximately 5,000ha in 1955-59 (Kusvie, 1960). Poppy production nearly stopped after Macedonia became independent in 1991, due to various reasons. Several years ago the company Alkaloid initiated organized production of poppy in cooperation with small farmers, providing them with variety Alkaloid 1 seeds and buying off the capsules. Finally, the production rose to 180 ha in 2012 and 90 ha in 2016 (SSO, 2017).

The present governmental policy (MAFWE, 2014) is increasing poppy production and breeding support due to the fact that the current production only satisfies 30% of national pharmaceutical requirements, while the rest is covered by import.

The importance of poppy production in Macedonia is illustrated by the image of a poppy flower, a proud synonym for the quality of Macedonian

agricultural products, is printed on a 500 MK Denars bill, while poppy capsules are printed on the Coat of arms (Figure 1).

## Traditional use of poppy

Historically, unfortunately armed conflicts was common in Macedonia, destroying the value of money and giving the opium an opportunity to be a stable “currency”. Therefore farmers were keeping opium as a “gold reserve”, selling it only in case of need. Common tradition was to save an opium “pie” as a dowry for daughters (Kusvie, 1960). This tradition, which lasted until the 1950s, largely contributed to the preservation of poppy landraces.

Some of the farmers today grow several plants in their gardens just to save the seeds, to prepare pies and cakes and sometimes even to produce a special type of the spice “K'cana sol” (smashed salt). This spice can be prepared in many variants from different ingredients. When it is prepared from poppy, the seeds are baked on 100°C for 30 minutes until reaching golden color and then are smashed and mixed with salt.

## Characteristics of poppy genetic resources

Jovanovic (2009) noted that Macedonian poppy populations in the 1800s probably arose from a cross between white-seeded poppy (*Papaver somniferum* var. *album*) and grey-seeded poppy (*P. somniferum* var. *griseum*). On the other hand, a CIA record from 1949 states “In Macedonia two varieties of poppy are cultivated: one with a white flowers and white seeds in a closed pod, the other purple, with black seeds in pods which split when ripe. Both varieties are used in production, but the white has a greater morphine content and is cultivated most”. This record also emphasizes that “Kavadar opium” (from the area of Kavadarci) is the best in the world, and that Yugoslav experimental stations created several new poppy varieties, one of which having a morphine content of 21.62%.

Kusvie (1960) described that cultivated poppy in Macedonia had 5-8 capsules per plant, roundish or oval, 2.5-5 cm in diameter and 10-14 stigmatic rays. Seeds varied greatly in color, from grayish white to light brown, which was not considered during selecting seeds for sowing.



Figure 1. Poppy image on the Macedonian coat of arms and a 500 Denars bill.

The varieties were yielding 300-400 kg of seeds in average per hectare, depending on the place and year. This author also noted that the quality of Macedonian opium is characterized with 15.9%-17.2% constant morphine content, 0.9-1.6% codeine, 7-9% narcotine, 0.7-1.7% thebaine and 1.2-3.3% papaverine.

Its most distinguishing trait compared to other opioms was its typical ultra-violet absorption spectrum - mostly attributed to a constant ratio between the thebaine and papaverine content.

According to the ratio between these two alkaloids, Macedonian opium belonged to the papaverine type unlike the majority of the Asian types. The highest morphine content (1.25%) was found in dry capsules grown in the Kavadarci region, while it varied in other regions between 0.47% and 1.05%. It can be concluded that the Kavadarci region has the best climate and soil quality enabling varieties to express their genetic potential. Siljanoski (2001) was analyzing two local Macedonian poppy populations and a landrace:

- *White-seeded poppy* (white flowers, cream seeds) and *Blue-seeded poppy* (dark purple flowers, light to dark blue-grey seeds), and the variety "Alkaloid 1". He found 0.53%, 0.67% and 1.80% of morphine content in dry capsules, 510 kg/ha, 632 kg/ha and 566 kg/ha of capsule yield and 680 kg/ha, 904 kg/ha and 864 kg/ha of seed yield, respectively.
- *Blue-seeded poppy population* (*Papaver somniferum* ssp. *turcicum*) is predominantly grown in Macedonia and is characterized by dark purple flowers (var. *violaceum*), light to dark grey seeds, 0.4-0.45% morphine, 400-600 kg/ha capsules and 600-800 kg/ha seeds (Boshev, 1996). When cultivated in Macedonia, it had the same content of morphine, but higher contents of the other two alkaloids (1.32%, 0.08% and 0.04% in Australia and 1.36%, 0.20 and 0.43% in Macedonia, respectively).
- "Alkaloid 1" has light purple flowers with dark purple blotches and blue-grey seeds. Its yielding potential is 600 kg/ha of capsules and 700 kg/ha of seeds.

Today "Pioner" is registered as local variety/ecotype along with two other ecotypes: "Arna II" and "Sinosemen opiumski" (Blue-seeded opium), but in reality seeds from these ecotypes are not maintained and are probably lost. In order to create a new improved variety, the Faculty in Skopje initiated a new poppy breeding program in 2010 within the project "Modern perspectives for cultivation and use of poppy in Republic of Macedonia" supported by Alkaloid.

#### Poppy breeding programs

Macedonian populations were used as genetic resources in the poppy breeding program, which was intensified during the period from 1960-1970. These efforts resulted in a new variety, Pioner (*Papaver somniferum* subsp. *euroasiaticum* var. *caesium*), created by the Faculty of Agriculture in Skopje and registered in the National Variety List in 1982 (Vasilevski, 2008).

It was obtained by crossing Macedonian opium poppy with a variety from Vojvodina cultivated for oil production (Angelov, 1989), but unfortunately it was not widely accepted by farmers. This variety had purple flowers with dark purple blotches, blue-grey seeds, yielding genetic potential for 1300 kg/ha of capsules, 1200 kg/ha of seed and 0.52% of morphine content.

Another breeding program was performed by the company Alkaloid which resulted in a variety ("Alkaloid 1"), registered in the National Variety List in 1996 and again in 2007. The original material for this variety, having high content of morphine and low content of codeine and thebaine, was introduced from Australia in 1979 (Siljanoski, 2001).

Different genotypes, which had been obtained by the Gatersleben genebank, and local populations were used as pre-breeding material (Stefkov *et al.*, 2012; Jankulovska *et al.*, 2012, 2013; Ivanovska *et al.*, 2012, 2016). Significant progress in several breeding lines which were selected from the local populations only has been achieved and analyzed up to 2015. The variability of several characterized traits is presented in Figure 2, 3 and 4.

**Table 1.** Breeding progress for yielding characteristics from 2012 to 2015 .

Genotype	Year	Capsule weight (g)	Seed/capsule weight (g)	Morphine content (%)
A/1-1	2012	3.57	3.72	0.84
	2015	4.34	4.83	1.01
A/1-14	2012	4.25	5.36	0.86
	2015	4.93	6.83	0.91
A/6-12	2012	2.25	2.84	0.91
	2015	3.06	4.31	1.12
M/3-9	2012	2.37	4.21	1.13
	2015	2.63	4.56	1.38
M/1-3	2012	2.34	4.15	0.85
	2015	3.76	5.75	0.92
S/5-11	2012	4.25	3.87	0.81
	2015	5.73	4.91	0.93



**Figure 2.** Variability of the flower color in Macedonian opium poppy breeding lines

**Table 2.** Contents of specific alkaloids of the improved lines

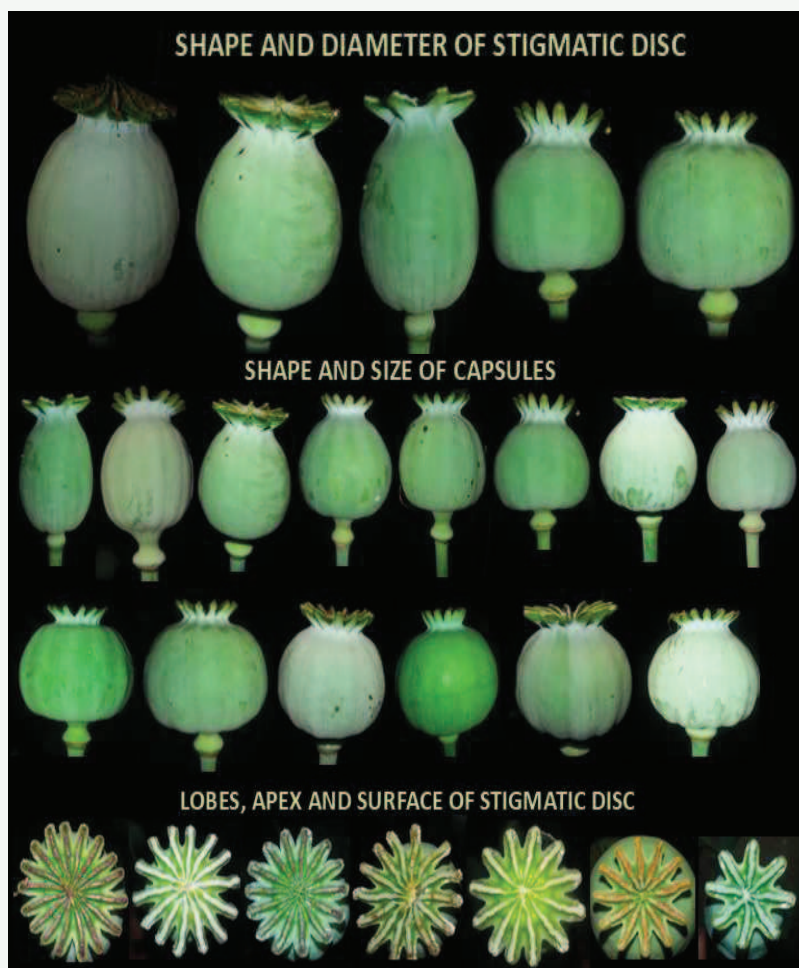
Genotypes	Morphine %	Oripavine %	Codeine %	Papaverine %	Thebaine %	Noscapine %	Total %
A/2	1.4077	0.0187	0.1055	0.3874	0.1386	0.0044	2.0622
S/5-11	1.1745	0.0000	0.1093	0.1558	0.0490	0.2816	1.7702
A/16	1.8310	0.0229	0.1695	0.1086	0.1891	0.0031	2.3242
Alkaloid 1	0.6643	0.0066	0.0583	0.2140	0.0247	0.1794	1.1474

The average weight of a capsule, seeds per capsule and morphine content in six improved lines are presented in Table 1. All lines have large round or round-conic closed capsules, so that seeds are not shed. Some of the lines were selected in the program due to their improved content of specific alkaloids other than morphine. In 2015/16, breeding lines were evaluated for the content of several alkaloids (from bulk samples of capsules). The best three lines compared with the variety "Alkaloid 1" are presented in Table 2.

Starting from 2014, The Faculty of Agricultural Sciences and Food has been establishing a seed collection of Macedonian landraces which currently contains 63 samples collected from 53 sites in Macedonia. Nearly half of the farmers maintain white-seeded landraces, claiming that the seeds are very old. Although some of the older farmers are not cultivating poppy any more, they have been keeping the seeds in jars in their basements for more than 15 years.

### Conclusion

The story of Macedonian poppy is a typical example of lost genetic resources that are valuable and may be needed and profitable in the future. All collected poppy samples may have the genetic potential for high morphine content as the old populations. Therefore they have to be multiplied, characterized, evaluated for their production and breeding value and saved in a genebank for future exploitation.



**Figure 3.** Variability of the capsule characteristics in Macedonian opium poppy breeding lines.



**Figure 4.** Variability of the seed color characteristics in Macedonian opium poppy breeding lines. Photo credits: M. Jankulovska.

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