INDUSTRIAL CULTIVATION OF OIL BEARING ROSE AND ROSE OIL PRODUCTION IN BULGARIA DURING 21ST CENTURY, DIRECTIONS AND CHALLENGES.

N. Kovacheva1, K. Rusanov2, I. Atanassov2
1Institute of Rose and Aromatic Plants, Kazanlak, Bulgaria
2AgroBioInstitute, Sofia, Bulgaria
Correspondence to: Natasha Kovacheva
E-mail: n.kovatcheva@abv.bg

ABSTRACT
The rose growing and flower processing is a centuries-old industry in Bulgaria which was a subject of substantial structural changes during the transitional period from state-ruled to market driven economy in the 1990s. The industry successfully passed in the 21st century becoming more open and dynamic. Here we review the industrial cultivation of oil-bearing roses in Bulgaria, the recent developments, current challenges and opportunities for future development.


Keywords: Rosa damascena, rose oil, industrial cultivation

Overview of industrial cultivation of oil-bearing roses in Bulgaria
The oil rose (Rosa damascena Mill. f. Trigintipetala Dieck) is an emblematic plant species for Bulgaria. Its large scale industrial cultivation and finest quality of the produced rose oil established worldwide recognized name of Bulgaria as a country of oil rose. A number of historical records point out that the rose-growing in Bulgaria started during the 16th century (7, 8) with production of rose water and rose oil which were widely used within the Ottoman Empire. During the 19th century the industrial cultivation of R. damascena, called also ‘Kazanlashka roza’ (the rose of town of Kazanlak, Bulgaria) spreads throughout the whole Sub-Balkan valley from the town of Sliven to the town of Klisura. Oil rose plantations were also established on the south slopes of Sredna Gora Mountain and the north slopes of the Rhodopa Mountain. The maximum planted area of 8951 ha has been reached in 1917 (29) and after that it gradually decreased. Presently, the industrial cultivation of oil rose is located in five areas: Kazanlak, Karlovo, Streltcha, Zelinkovo and Chirpan.

The industrial rose cultivation in Bulgaria involves exclusively the species R. damascena Mill. f. Trigintipetala Dieck (Kazanlashka roza), due to its higher rose oil content and superior essential oil quality. At present there are also small areas planted with Rosa alba L. (white oil rose). Beside the industrial cultivation of R. damascena, during the last century small plantations were established from other roses as well, R. gallica L. subsp. eriastila Kell. var. Austriaca Grantz. f. panonica Br (Stambolska roza), R. francofurtana var. Agatha (Sakarska roza), R. centifolia and R. rugosa. The lower rose oil content and different composition of the essential oils from these roses suppress their further cultivation at industrial scale.

Recent developments in the rose industry
Oil rose growing and flower processing is a centuries-old and well established sector of the Bulgarian agriculture. It dominates the business activity and employment of a number of towns and villages located in the Rose Valley and other rose growing regions. In spite of this, the rose-growing industry has gone through significant changes during last two decades related mainly to the transition from state-ruled to market economy. Till 1990 the land of rose plantations was co-operative property and
rose growing and flower harvesting were done by agricultural co-operatives. All rose flower processing facilities were state property and the export of rose oil was under a state monopoly. The transition period during 1990s in Bulgaria substantially changed the entire structure of the rose-growing industry. Today, all rose plantations and rose flower processing facilities are private property. The rose-growing, flower harvesting and rose oil distillation is managed by private owners and companies and very rarely by co-operatives. The change of the land property and slow implementation of the agricultural reforms during the transition period resulted in nearly complete lack of investments for renovation and establishment of new oil rose plantations for a long period from 1990 until 1996-1997. This led to more than twice reduction of the rose-growing areas (Fig. 1), (22, 28, 29) partitioning of a number of large rose plantations, aging of the cultivated roses and substantial overall reduction of the volumes of the harvested rose flower. The process of stabilization and recovery of the national economy, started after 1997-1998, bringing increase of the volumes of new investments in the oil rose industry and further changes to its organization and structure. A large part of these investments were part of the implementation of the EC Operational Programs and supported by the Agriculture State Fund. Most of the old rose plantations were renovated and new plantations were established. Thus, the total areas of rose plantation in 2008 reached the volume of industrial rose cultivation from 1970s and account for approximately 3500 ha (Fig. 1) (19). Presently, the largest areas of the rose plantations are located in the Rose valley, in the region of Kazanlak (Stara Zagora district) - 42% and the region of Karlovo (Plovdiv district) - 41% (Fig. 2a). The regions around these two towns have the most favourable soil and climatic conditions for growing the oil rose. During the last 2-3 years there has been a very fast development of rose plantations around the town of Streltcha (Pazardzhik district) and village of Zelnikovo, where the planting areas have grown twice. The changes of the property, expanding of the investments and rose planting areas and elimination of the state monopoly on the rose oil trade resulted in substantial changes in organization and structure of the entire rose industry. Some of the rose growing companies, owning larger rose plantations (e.g. over 40 ha), established own flower processing and oil distillation facilities in order to close the production cycle from raw material to final rose oil product. At the same time, some of the rose flower processing companies invest in establishment of own rose plantations and became more independent from the rose flower suppliers. It is expected that these changes in the industry structure will make it more sustainable with increased efficiency of interaction between rose growing and flower processing segments. The new trends in the rose industry from the beginning of 21st century brought also the first direct investments from international fragrance and bioproduct companies in this sector. Some of the foreign companies simultaneously established rose plantations and flower processing facilities (e.g. www.biolandes.com). From the other side, the discontinuation of the state monopoly for rose oil export brings diverse models of trading rose oil products. Now it varies from direct trade and export from rose oil producers to operation of increasing number of national and international trade companies. At present, the rose-growing in Bulgaria is a dynamic industry with increasing complexity of property and management models, internal interaction and international exposure.

![Fig. 1. Dynamics of rose growing in Bulgaria](image1)

![Fig. 2. District distribution of rose industry](image2)

(a) distribution of rose growing areas in percentage;
(b) allocation of rose industry work load as total number of employees

### Employment and labour cost

Presently the rose industry in Bulgaria involves above 65 000 employees, as most of them are seasonal workers from the three rose growing districts (Fig. 2b). The harvesting of the rose flowers continues for less than a month and starts during the second half of May. It is the most labour consuming process in the rose industry. This is also one of the most decisive factors which influence the overall production and price of fresh rose
flower and rose oil. Since it is a seasonal job often it is hard to secure the necessary number of workers. During the last decade, a main part of the seasonal workers that is hired for rose harvesting is of a gipsy (rom) origin. This increases the social impact of the rose growing industry, reduces the unemployment levels and provides important opportunity for increase of the incomes of low qualified local people. A steady increase of payment for rose harvesting took place during the last decade. The main reason for the increase of the labour cost is due to the lack of enough seasonal workers in the regions near the rose plantations. Further increase of the labour cost is unlikely since it will push up the price of the rose flower to levels which will hamper the sale of the produced rose oil. Additional problem for efficient harvesting of the rose flower is the organization of the harvest campaign. Before 1989, as part of the state-ruled economy, the rose harvest campaigns were centrally organized and involved a large number of students. Nowadays, the hiring of seasonal workers and harvest management is done by the owners of rose plantations. During the last few campaigns this practise resulted in fragmentation of the work force, which let some plantations with up to 30% of rose flowers not harvested. The incomplete harvesting reduced the yield and increased the trade price of the rose flower and distilled oil. Thus further improvement in the overall organization and management of the rose flower harvest campaign will bring direct impact for the rose industry without significant investments.

**Rose oil production and market**

Traditionally, the larger part of the harvested rose flowers in Bulgaria is used for production of rose oil. At present, around 90% of the rose flowers are processed to rose oil, 5-6% to rose concrete and 3-4% to rose water. Small amounts of rose flowers are used by the food industry for production of jams and liqueurs. The annual production of Bulgarian rose oil during the last 15 years ranged between 870 and 2000 kg with exception of the year 2002- around 650 kg due to the unfavourable climatic conditions (Fig. 3) (19, 22). The larger part of the produced rose oil is directed to export. During the period 2001-2008 the annual export of rose oil raised from 1020 to 1800 kg (period 2001-2008 the annual export of rose oil raised from 870 to 2000 kg) (19, 22). The price for 1 kg of Bulgarian rose oil increased from 3217 euro in 2001 to 4600 euro in 2008 (Fig. 4a) (19, 28). At the same time the average price for 1 kg of Bulgarian rose oil increased from 3217 Euro in 2001 to 4600 Euro in 2008 (Fig. 4b) (28). An important feature for the period is the steady increase of the volumes and prices of the produced and traded organic rose oil. Generally the price of the produced organic rose oil is approximately 20% higher than the rose oil produced with regular agricultural practices.

The main consumers of rose oil and rose concrete are the big cosmetics and perfumery companies. The world annual consumption for rose oil accounts for 3000 to 4500 kilograms (2). Bulgaria and Turkey are the main producers of rose oil supplying 80-90% of this product to the world market (2, 6, 11). The rest of the world production is supplied by Morocco (2), Iran and Mexico (11), France and Italy (24), Lebanon (2), India (4), Russia and China (3). New producers emerging on the market are Afghanistan (2), Saudi Arabia (5, 23) and Egypt.

The Bulgarian rose oil is a key ingredient used by leading companies like Kenzo, Chanel, Dior, Fendi, Bulgari, Faberge and many others (13).

The relatively constant levels of the world consumption of rose oil over the years makes the rose oil market highly competitive for both traditional and emerging producers. The high quality of the Bulgarian rose oil, century old traditions and world reputation of the country make it a leading producer and supplier in the world market. There is a potential for further increase of the volume of the rose oil supplied by Bulgaria through reduction of its production cost, preservation of the high quality and increase of the share of produced organic rose oil. To support the production and export of rose oil a National programme for development of the aromatic and medicinal crops in Bulgaria 2007-2013 is currently implemented. It is focused on further increase of the competitiveness of the

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**Fig. 3. Annual production of rose oil in Bulgaria**

**Fig. 4. Annual export of rose oil from Bulgaria**

(a) annual export of rose oil in kilograms;
(b) average price of the exported rose oil, annually
Bulgarian rose oil through reduction of production costs, preservation of the superior quality and increase of the volumes of organic rose oil.

**Fig. 5.** The main destinations for Bulgarian rose oil export

The current size of the rose plantations in Bulgaria could secure the production of at least 1500-2000 kg of rose oil annually. It is a widespread opinion among the rose-growers and rose oil producers that the accent for further development of the rose industry has to be put on implementation of more efficient production practices rather than on establishment of new rose plantations. The average production from old and not well maintained rose plantations is around 1000-1500 kg flower/ha. At the same time the average production from new (more than 3 years after the establishment) or renewed plantations kept in an excellent state is around 4000-5000 kg flower/ha, (in some years it may reach 8000-10000 kg flower/ha). Thus implementation of more efficient agricultural practices is a key factor for further increase of the overall flower production, reduction of the production costs and consequently an increase of the rose oil export and industry earnings. There is a steady improvement of the agricultural practices in the rose industry during the last few years. Now the rose-growers have larger access to modern agro-techniques and credits for purchasing of agrochemicals. The global warming and irregular rainfalls forced many farmers to use drip irrigation, which leads to substantial increase in flower yield from the irrigated plantations. The renovation of rose plantations and establishment of new ones is based on the use of high quality certified planting material supplied by licensed producers. It is expected that all this could support the sustainable increase of rose flower yield and overall production during the next decade, without further expanding of the area of rose plantations. The more efficient management of rose flower harvesting and especially the efficient direction of the seasonal workers between the rose plantations is one of the current challenges, following the improvement of rose growing practices.

The other main challenge to the rose industry at present is the increase of the volume and proportion of the produced organic rose flower and oil. There have been steadily growing market demands for organic rose flower and oil during the last decade. The production of organic rose flower and oil requires adoption of new rose growing practices, separate harvesting and processing of the rose flower. The switch to organic rose growing requires additional investment and technological

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<tr>
<td>Average flower weight (g)</td>
<td>2.37</td>
<td>2.39</td>
<td>2.4</td>
<td>2.43</td>
<td>2.37</td>
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<tr>
<td>Flower yield (kg/da)</td>
<td>732</td>
<td>604</td>
<td>562</td>
<td>667</td>
<td>723</td>
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<tr>
<td>Rose oil content (%)</td>
<td>0.054</td>
<td>0.047</td>
<td>0.045</td>
<td>0.052</td>
<td>0.051</td>
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<td>Rust damages (%)</td>
<td>18.3</td>
<td>19.7</td>
<td>6.1</td>
<td>7.3</td>
<td>13.9</td>
</tr>
<tr>
<td>Black spot damages (%)</td>
<td>16.2</td>
<td>15.5</td>
<td>4.5</td>
<td>8.2</td>
<td>20.4</td>
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<tr>
<td>Frost damages at temperature of -30°C (%)</td>
<td>58</td>
<td>57.5</td>
<td>15.3</td>
<td>26</td>
<td>50</td>
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**Rose oil composition**

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<tr>
<td>Citronellol (20-34%)</td>
<td>23.04</td>
<td>19.91</td>
<td>21.09</td>
<td>20.16</td>
<td>21.91</td>
</tr>
<tr>
<td>Nerol (5-12%)</td>
<td>7.59</td>
<td>8.37</td>
<td>6.07</td>
<td>7.19</td>
<td>6.24</td>
</tr>
<tr>
<td>Geraniol (15-22%)</td>
<td>18.87</td>
<td>17.57</td>
<td>16.61</td>
<td>15.34</td>
<td>16.78</td>
</tr>
<tr>
<td>Paraffins C17 (1.0-2.5%)</td>
<td>3.21</td>
<td>1.53</td>
<td>3.90</td>
<td>3.64</td>
<td>4.27</td>
</tr>
<tr>
<td>Paraffins C19 (8.0-15.0%)</td>
<td>9.34</td>
<td>8.79</td>
<td>5.93</td>
<td>7.75</td>
<td>10.70</td>
</tr>
<tr>
<td>Paraffins C21 (3.0-5.5%)</td>
<td>5.75</td>
<td>14.05</td>
<td>4.49</td>
<td>5.15</td>
<td>4.82</td>
</tr>
</tbody>
</table>

1. - population from selected *R. damascena* clones used in present rose plantations;
2. - average percentage of plants attacked and damaged by rust (*Phragmidium mucronatum* (Pers.) Schltdl.) and black spot (*Diplocarpon rosae* Wolf);
3. - frost damages at temperature of -30°C, as percentage of damaged branches;
4. - the main rose oil compounds described in the ISO 9842 rose oil standard
period to pass through the organic licensing. During the last few years a number of rose growers established various in size organic rose plantations and currently there is a gradual increase of the volume of the produced organic rose flowers and oil. Thus, high rate of organic rose oil production could be expected within the gradually increasing volumes of overall rose oil production in Bulgaria.

Improvement of the oil rose

The improvement of the oil rose has to be considered in the frame of the tight prerequisites and limitations which are part of the centuries old rose industry (discussed in 25). Thus, the preservation of the traditional odour and composition of the extracted rose oil is an ultimate prerequisite for oil rose breeding programmes. In order to preserve the authentic scent of the oil rose, sexual intra- and inter- specific crosses have been avoided in the oil rose breeding. There are four cultivars of R. damascena registered so far (Table 1). Two of them, cv. Svezhen and cv. Iskra have been developed through clonal selection. The other two, cv. Elejna and cv. Janina have been developed through chemical and radiation mutagenesis, respectively. Although the essential oil extracted from the four cultivars comply with the rose oil standard and they possess excellent parameters, these cultivars have not been widely used for industrial rose cultivation. At present the predominant part of the rose plantations is based on cultivation of an improved population from selected oil rose clones. It was believed that cultivation of the population of R. damascena clones rather than single cultivar/clone contribute to the rich composition of the produced rose oil due to the proper blending achieved in the process of rose harvesting and processing. The growing demands from increased productivity, reduction of the production costs and organic rose oil production require development of new disease resistance cultivars with improved parameters. Although the gene transfer provides straightforward solutions for most of the breeding tasks its practical application is not realistic at present due to the low public perception of genetically modified organisms in Bulgaria and restriction for GMO oil rose release in the current national legislation. Since R. damascena does not offer sources for resistance to the main economically important diseases and pests, resistant oil rose varieties could be developed only through inter-specific hybridization with closely related species. The implementation of such breeding programmes is largely complicated by the prerequisite to preserve the rose oil composition and rose flower morphology. The possibilities for application of complex molecular breeding and metabolomics approach for inter-specific cross breeding of improved oil rose varieties were discussed in two recent reviews (25, 26).

Capacity for product diversification

At present, the harvested rose flowers in Bulgaria are used predominantly for production of rose oil, as well as for relatively small volumes of rose concrete and water. Nearly the entire production is directed to export. One of the current trends during the last few years is the increase of the volumes of rose oil, concrete and water utilized by the Bulgarian cosmetics and perfumery industries. The increasing investments combined with the restructuring of the larger part of the industry elevated its competitiveness, products range and quality (12, 14, 15). The further increase of the exported volumes of Bulgarian cosmetics, perfume and odorant products involving rose flowers offers attractive opportunity for expansion of the rose growing industry.

The diversification of the rose flower products could be of a great importance for the future development and expansion of the rose growing industry in Bulgaria. The relatively constant volumes of world consumption of these products make the market sensitive to oversupply and subject of frequent fluctuation. The diversification of the rose flower products could provide new dimensions for the traditional rose growing industry, increasing its flexibility and rose flower market volumes and demands. Recently the development of the Bulgarian rose industry towards utilization of the rose flowers as food and liqueur ingredients has provided new opportunities. During the last years there has been increasing production and supply to the national market of various jams, sweets, yoghurts and liqueurs involving rose flowers. One of the main challenges in this direction is the implementation of adequate market strategy for sustainable export of such products.

A still less realized opportunity for utilization of flowers from oil-bearing rose is the production of dry flowers. The world market of dry flowers has been expanding during the last decade (16), and the Bulgarian oil-bearing rose has a capacity to take a share utilizing its world famous name.

In spite of a number of reports on the positive health effects from various preparations of rose flowers and processed products (1, 17, 18, 20), so far the use of rose flowers for medicine production is poor. The rose flowers are successfully used in traditional herbal products (30) and aromatherapy (12), but not for purification of specific compounds as medicine ingredients. The progress in utilization of rose compounds for medicine production is expected to be slow due to the high metabolite complexity of the rose flowers and processed products and insufficient information on the health impact of the individual compounds.

Conclusions

The centuries-old Bulgarian rose growing and flower processing industry successfully entered the 21st century with improved and flexible structure, product and market opportunities. There is a clear capacity for further expansion of the rose flower production, processing and product diversification, which will require implementation of well targeted investment strategies, breeding of improved varieties and in some cases adoption of advanced flower processing technologies.
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