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Production of Medicinal and Aromatic Plants in the East-European Countries (**)

1. *Presentation of Activity and Technical Results of the Institute.*

Among the Hungarian institutions dealing with various aspects of medicinal plant research is our Institute, which looks back upon the most extended professional history, comprising 72 years. It plays, even now, the most important role in complex researches associated with this topic, ranging from botany to analytical chemistry. Our investigations are always oriented towards the utilization of active biological components of natural origin. It is a fact that our Institute was at first established among similar institutes all over the world, and since its founding it has also assured quality control. The research basis of our Institute was established in the light of the wealth of the Hungarian flora. Furthermore, after its breakthrough during the last two decades, it was the chemotaxonomy which assured the realization and introduction of medicinal plant production. In the past 15 years, a series of phytoclimbers was put into operation, creating the physiological basis for advanced agrotechnics.

The interdisciplinary character of our investigations is mainly determined by biology and chemistry, although also economic rules are always taken into account. Whereas the subject of our research work is made up of the two hundred medicinal and aromatic plant species occurring naturally or being cultivated in Hungary, investigations are focused on the four most important ones: poppy, ergot, mustard and foxglove. There are also several selected anise, fennel, caraway, coriander, basil and tarragon dragoncell as spice plants at our disposal, recognized by the Hungarian authorities. Of the plants with essential oil content, camomile, lavender, mint and sage cultivars were bred.

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(**) Presented at the International Congress on « Medicinal Plants » (Sansepolcro (AR), 17-19 October - Roma, October 20th 1987), organized by the Accademia Nazionale delle Scienze detta dei XL.

Preservation of the characteristics of all these species remains the task of the Institute, therefore selections are made continuously. Due to this activity, *seeds of super-elite and elite quality* are produced every year, which are sold even abroad, through commercial agencies. Such type of production is supervised by the competent Hungarian state office.

Returning to the most important plant species, it can be concluded that the best results were obtained certainly in ergot breeding. There are so-called monoalkaloidic strains for ergotamine, ergochryistine, alpha- and betacryptine production at our disposal, as well as a strain for combined ergocornine-ergocryptine production. Alkaloid contents of our tamine and chryistine-producing strains amount to 1%, and those of the others vary between 0.3 and 0.6%. Our alpha-cryptine strain is almost pure, the beta-cryptine strain contains more than 60% of this alkaloid, plus 25% of alpha-cryptine. Good yields are assured by these varieties, but average yields are rarely higher than 200 kg/ha. Ergot cultivation is fully mechanized, gametocides may increase yields by 10-40%. We used this year a hereditarily sterile rye cultivar which gives double to triple yield.

As to oilseed poppy, this crop is cultivated in Hungarian agricultural cooperatives and state farms as a spicy plant, since production of blue-seeded varieties seems to be more economical and capsule prices amount only to 20-40% of that of the seeds. Poppy breeding looks back upon a fifty years' history in Hungary. There is a cultivar called 'Blue Danube', which was bred in our Institute and is today the standard. This variety is of high productivity, yielding 800 kg seed/ha and 700 kg capsule/ha on the average. Recently, another poppy cultivar ('Blue eye') was selected and cultivated on 20% of the poppy-producing area. Its seed yield surpassed by 20-30% that of the standard, and its alkaloid content showed a twofold increase over the standard. The colour of the seeds, however, is not so beautiful, compared to the standard. Production area of this cultivar increases more slowly as has been expected. Cultivation of the crop is fully mechanized, and all methods of chemical weed and pest control are elaborated. Incidence of diseases in the crop culture is quite rare.

Multilinear breeding work on the mustard cultivars used in Hungary was set in on 20,000-25,000 ha. The piquant character of these cultivars is assured by their isothiocyanate content. Of the seed constituents, it is the fatty oil that must be ameliorated through alteration in its erucic acid content. This can be done in two ways: it must be either increased or decreased, in the first case for industrial purposes and in the second one for utilization as paste or cooking oil. Average mustard yield amounted to 1.5 t/ha in some agro cooperatives; however, even 3 t/ha could be achieved. Production of the crop is fully mechanized. Weeds and insects are controlled chemically. Provided that the cropping area is too large, small agricultural airplanes can be profitably used for this purpose.

The fourth most important crop is foxglove. It is well known that this species is highly heterogeneous both morphologically and chemically. During its

selection, endogamic crossing is needed to maintain viability, but the success of selection is threatened from the chemical point of view by successive crossings, i.e., lanatoside C content may be affected. We were unable to reach the level of the East-German research workers, who reported in Antwerp in 1985 that their selected strains had 0.6% lanatoside C content. We are yet not above 0.4%, although in some individual plants already 0.6% was achieved. In order to preserve these individuals and avoid their immediate crossing, tissue cultures were introduced already four years ago, and now we have some sister-lines, which support crossing, and give viable descendants. First evaluation of these lines was made just in the current year, and promising results were obtained. We have some problems also with the cultivation of the crop, since it requires better soils and good conditions. Mechanization is complete, but control of the various enemies is very expensive. The greatest problem is caused, however, by artificial drying, with its high energy consumption. Therefore, we returned to the ancient and natural methods of drying in granaries, but in this case, we have to face the shortage of manpower.

Our Institute maintains manifold relations with the practice. I spoke already about one of our tasks, namely, that we have to furnish seeds, spores and stolons. Another aspect of our work is that we have to intervene in the production of medicinal plants, as local, leading organizers, according to the needs of agriculture or industrial enterprises. We organize frequently discussions between producers and representatives of the specialized industries in our Institute, in order to exchange experiences. We take part every three years in the organization of special postgraduate courses at the Horticultural University. We become acquainted with their problems, and we inform them on our technical novelties by publishing our results in *Herba Hungarica*. Our Institute is responsible for the quality control of medicinal plant products too. We have to accept or reject all items before commercialisation which may be originated from import, going to export, used directly or elaborated in Hungary.

Now, let us turn toward the figures relating to the production of medicinal and aromatic plants and their derivatives in Hungary. Percentage distribution of our 50 cultivated species on the cropped area is as follows:

aromatic, spicy and essential oil-yielding plants	10-35%
ergot	15%
oil-seed poppy	20%
mustard	30%

the remainder is occupied by different medicinal plants of minor importance.

One-third of the products is utilized in Hungary, one-third is directly exported, representing, in the case of medicinal plants, 10 million US\$. Our traditional markets are the German-speaking and the North European countries. One last third part of these materials is getting into the factories, where they are processed into food-cosmetic- and pharmaceutical products. Bulk alkaloids and essential oils are shipped to the West European countries and

the USA, representing a value corresponding to 12 million US\$, while food, hygienic and special pharmaceutical products get into the East European countries, for a value of 15 million US\$. We are importing significant amounts of tropical and subtropical medicinal plants and, to a lesser extent, we are also importing from East-European countries. Their total value amounts, however, only to 6 million US\$.

2. *Analysis of Medicinal Plant Production in the East-European Countries.*

Let us turn our attention now to the East-European countries. Our nearest partners are the Yugoslav and the Czechoslovakian producers. In Yugoslavia, spontaneous aggregations of small-scale agricultural growers are dealing with the cultivation of medicinal plants, especially in Slavonia, where ergot is produced under the supervision of the LEK factory. Production of poppy and other medicinal plants is organized by the ALKALOIDA factory on several thousand hectares, although plots are of medium size. Medicinal and aromatic plants are cultivated on large areas in Croatia and Voivodina too, where camomile is the most important plant, although poppy, sage and Pyrethrum are also cultivated. They are highly specialized in production of tea bags and, in addition to pharmaceutical products, they bring them to the international market.

In Yugoslavia the situation is the same as in Hungary: the production of medicinal plants and their derivatives is under the control of government-owned enterprises and companies; state authorities do not intervene either in prices or in contracts, nor do they prescribe target-figures. The only condition to be met is the profitability of agricultural and industrial plants, or firms, dealing with marketing.

Different situations may be found in other East-European countries, where production of medicinal plants is directed by the government through prescribed target-figures, although the extent of these interventions as well as their results vary markedly among the countries.

Let us begin with Czechoslovakia. Resources are given by the state at the disposal of the firms dealing regionally with medicinal plants, and the state makes decisions on the plants to be cultivated and on the investments too. The most important plants are ergot and camomile. The first one is investigated in Prague, in the Institute of Pharmacy, which belongs to the Ministry of Health. Studies on camomile are carried out in a specialized research institute at the University of Kosice belonging to the Ministry of Agriculture, where more than 30 graduates are working. Everything concerning the cultivation of this crop is the task of this Institute, e.g., seed and stolon production, choice of machines and chemicals, with the exception of the cultivation itself, which is done in state farms or in agro-cooperatives, at prices predetermined according to plan. In addition to these two most important plants, there are also about 30 cultivated medicinal plant species such as poppy, foxglove, plants of tropane-alkaloid content, etc.

In Roumania, plans, prices and enterprises are determined on a governmental level in the case of medicinal and aromatic plants. The country is divided into regions, and they must be self-supporting, but if surplus production results, this gets into national factories or is exported. The most important plants are poppy and those which contain tropane or steroid alkaloids. Spicy and essential oil plants are cultivated on a large-scale level over extended areas in state farms and agro-cooperatives. Nevertheless, yield losses are high, methods of cultivation on an ancient level. Researches are diversified, the agricultural basis is established at Fundulea, not too far from Brassovic. The flora is extraordinarily rich; plants growing spontaneously are regularly collected for processing and exportation.

The situation in Bulgaria is nearly the same, although the system of organization differs markedly between Roumania and Bulgaria. In the latter, there are large trust-like agro-industrial complexes, which deal with medicinal and aromatic plants, from cultivation and processing to marketing. These complexes have a great enough potential to direct this branch of production according to governmental requirements, although they are primarily influenced by their own interests. They make decisions on plans, prices, and — although to a lesser extent — on investments. Because Bulgaria is traditionally a country of cooperatives, also these are participating in the complexes. For a long time past, aromatic plants were of primary importance, although recently increasing attention was given to medicinal plants too. The plant cultures occupy large areas, production is fully mechanized and chemical control treatments are applied. Lavender and mint produced here can successfully compete with the same plants grown all over the world. Manpower is mainly absorbed by the industry, therefore only a small part of the remainder deals with plants of essential oil content, e.g., rose. High quality products are prepared, sometimes in quite large quantities. A great proportion of their products gets into the East European countries. Also here, research work is centralized, and the specialized institutes of Sadovo, and Kazanlik are very well equipped. Directors of the complexes take care of innovation and investments.

Let us now look at two northern countries, the German Democratic Republic and Poland. In the GDR, medicinal plant research is not a matter of government interest. It is the *Arzneimittelwerke* in Dresden which deals with organization and coordination of the very specialized research work, almost entirely limited to foxglove. Interest in the production of steroids and morphine alkaloids has ceased. A station at Bernburg deals with the activities that are still of interest, although this is only a reminiscence of the 60s. Some spicy plants are cultivated over large areas, with full mechanization and chemical treatments, e.g., mustard and marjoram, but sometimes great harvest losses occur. This decline due to an extraordinary rate of industrialization can be understood but by no means justified.

Recovery of Poland began just after the economic crisis, which caused severe damages to medicinal plant production and processing. At the end of the 70s there was a very profitable cooperation between the producers of me-

dicinal plants and the laboratories of the galenic industry. The rate of production was high enough to meet their own needs, and in addition, good commercial connections were simultaneously maintained with both eastern and western countries. Since I had the opportunity to speak with the head of the Research Institute for Medicinal Plants of Poznan, Professor Lutomski, I can give you primary information on the actual situation, as follows.

Production of medicinal plants is mainly carried out in small peasant farms, on areas rarely reaching the size of 5 ha. Since the branch of production belongs to the Ministry of Agriculture, research work is organized by the Institute mentioned above. A change in this organization arrived in 1986, when 3-5 state farms, which were autonomous till that date, became dependent on the Institute. This decision assured greater possibilities of production of seeds required, and introduction of more advanced methods of cultivation. There are not such large-scale farms as in Hungary, the area at their disposal does not exceed 1000 ha. Nevertheless, this change will assure the possibility of production at a higher rate. One of the disadvantages of the Polish system of organization is that it separates the production of medicinal plants from that of plants for cosmetic purposes. The latter are produced according to contracts between small-scale farmers and cosmetic factories, and this may be the source of competition between the two directions: neither of them can be sure that plants of some ambiguity, such as peppermint or thyme, would be their own basis of industrial production, or that of their competitors. As to the research institute, it does not supervise the quality of medicinal plants although it provides arbitrary judgement in cases where opinions or realizations conflict. Therefore its influence seems to be *post festum*, but it sets guidelines for further contracts. As to the research work, it should be noted that important pharmaceutical studies are carried out on utilization of sage for different purposes. Also there are some promising results in the improvement of alkaloid-producing ergot and oil-seed low morphine poppy strains. Mechanized agrotechnology and chemical plant protection are used in large-scale production.

In the Soviet Union, methods of cultivation of medicinal and aromatic plants differ markedly, as will be seen later. Organization is grandiose, not only because of the distances, but also due to the fact that population is rapidly increasing, and it will amount within a short time to 300 million. This urgently necessitates the construction of networks of commercial roads, etc. Each republic has its own specific administration and government with total responsibility. This situation can not be compared to what I have experienced in East-European countries or other countries of similar dimensions. The Flora, e.g., is very rich, containing 21 thousand species including 2500 of medicinal importance and of them 200 of current use.

Let us look at the organization. Production of pharmaceutical plants is governed by the Ministry of Pharmaceutical Industry, while aromatic and spice plants belong to the Ministry of Alimentation. Cultivation of medicinal plants is organized by two institutes, of which the Research Institute for Medicinal Plants deals with state farms and specialized farmers' cooperatives. The

first organize 9 experimental bases in different zones and the second about 30. All of them are large-scale producers; the area under cultivation sometimes reaches the size of 10,000 ha, even the average amounts to 4000 ha. Production is fully mechanized, including weed control. The row spaces, however, are wider than is required by the plants, and yields reflect that their biological potential is not fully utilized. Certain chemical products are applied especially against diseases and insect pests, and also herbicides are increasingly introduced into the weed control schemes. Drying of the products in the northern farms is by artificial means, while in the southern part of the country sunshine is efficiently utilized for this purpose, using shadowing shelters if necessary. Medicinal plants are processed into various tea-preparations in small-scale enterprises, while pharmaceutical products are manufactured in specialized factories. Even the research institute has its own small-scale plant of medium capacity, but for the extraction of alkaloids an immense unit is operated at Tchimkent. In addition to the central institute, some other institutes are dealing with medicinal plants: one in the Georgian Republic in Tbilisi and another in Vladivostok, which are the two most important ones.

Let me here point out an example representing the responsibility of the government: the case of *Solanum aviculare*, whose area of cultivation occupied more than 6000 ha this year in order to assure production of corticoids in spite of the well known fact that it does not bring any profit either for agriculture, or for industry, — but it is needed!

Cultivation of essential oil-containing plants is not centralized in the same way as that of medicinal plants. While in state farms production is carried out in large areas, amounting to about 6000 ha, I saw in Moldavia some farms extending over 18,000 ha. Cultivation is mechanized, and distillation-units are operated in specialized farms more or less continuously. Thus you can imagine what a high degree of organization is necessary for the total utilization of this capacity. As to their location, farms producing medicinal plants are more scattered, while plants producing essential oil are regrouped around the Black Sea and in the Caucasian Republics. This situation alleviates the scientific influence of the Research Institute for Essential Oils at Simferopol. There are no large quantities produced in the Institute, its laboratories serve exclusively for experimental purposes. It has, however, a small-scale factory, where only specialized equipment is manufactured for the cultivation and distillation of aromatic plants. Breeding of varieties of high performance is continuously carried on, and they possess biologically important stocks, consisting not only of plants already established but also of those which can be introduced into production according to the needs.

In Armenia (USSR) a hydroponic methods was developed, assuring alternatively water and air to the plants. The development of plants is faster, the yield is higher and since this method needs less area, phytosanitary intervention is facilitated and more effective. One example of effectiveness is the soilless production of Rose geranium. Under hydroponic conditions the plants used to develop 30-40 days sooner than in soil, which makes it possible to obtain two

TABLE 1

Fillers	Contents of essential oil, %	On area of hydroponic beds		On the whole area of hydroponicum including paths	
		Yield, t/ha	Output of essential oil, kg/ha	Yield of green mass, t/ha	Output of essential oil, kg/ha
Gravel	0,139	138	192	93	129
	0,118	117	138	78	92
Gravel + vulc. slag	0,127	133	169	89	113
	0,111	126	136	81	90
Gravel + pumice	0,127	130	163	87	111
	0,119	123	147	80	96
Vulcanic slag	0,137	123	168	82	112
	0,126	111	140	74	93
Soil (control)	0,125	23	31	23	31
	0,106	21	22	21	22
State farm "Geranium"	0,075	26	19	26	19

harvests a year instead of one. The harvest of green mass under open air hydroponics during 5 years of experiments has always resulted in multiplied yield compared with field conditions or the soil control plot (Table 1).

The essential oil content had always been somewhat higher than in the soil, therefore the calculated oil production of the whole area of hydroponics gave 111-129 kg/ha oil instead of 22-31 kg/ha obtained from the control. This oil had better quality in hydroponics because isomenthone (an inconvenient constituent) was only 6-8%, while for the control oil, admitted by state standards, it was up to 15%.

On the basis of this study large-scale production was achieved in Armenia by a definite technological direction accomplishing industrial cultivation as a new branch of applied biological techniques. Products are entirely utilized by the cosmetic industry of the Soviet Union, and only an insignificant proportion gets to the international markets.

If we come to a standstill after such a long East European trip, then we can say that it was only an aircraft-tour, and many details fail or are controversial. But I wanted to give you only an impression about the huge efforts which are made in these countries both from the biological and technological points of view. If the evidence reported here, was convincing, I am very happy, and I hope that all this information will encourage you in your personal work. I wish you very good results, surpassing those which I could present you.