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Scientific and Economic Aspects Related to Chilean Medicinal Plants (**)

America and its medicinal flora

During the 16th and 17th centuries, Spanish, Portuguese, Italian, Dutch and English navigators opened the ways to the Indies and at the same time introduced a series of natural products into Europe, creating an enormous commercial market for these. Suffice it to mention only a few examples, such as *Hevea brasiliensis*, or India rubber; *Cinchona officinalis* L., or quinine, etc.

In 1596 Sir Walter Raleigh delivers in Europe the first descriptions concerning the dart venom used by American aborigines; these were later expanded by Humboldt and Bonpland and by the German botanist Schomburgk who made interesting studies about the flora of British Guiana. In 1880 Planchon informs about the system employed by several Brazilian aborigines for the preparation of their deadly "curare", with which they poison their arrows.

It is worthwhile to mention that the history of "curare", the preparation of which was surrounded during long periods by legends and mystery, is an example — through a series of anthropological, ethnographic, botanic, pharmacological and, later, chemical studies — of an interdisciplinary research concerning a problem of practical interest, which was developed during the 17th century and is still going on today.

American cultures, especially those of the Incas, Aztecs and Mayas, were able to supply modern civilization with a number of matters of great importance to medicine: coca leaves, peyote, ipecacuana, and others.

Once chemistry became a science — at the beginning of the 19th century — plant extracts and active principles began to be investigated with ever-improving

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techniques. During 1818 and 1820 strychnine and quinine where isolated from extracts of South American plants.

Later, chromatographic separation techniques and spectrophotometric methods enriched the knowledge of alkaloids, terpenes, steroids, etc. It thus happened that, among other examples, the so-called "curares", formerly considered simply venoms, are now used in surgical anesthesia. Since 1940, R.E. Marker realized a remarkable systematic research of the flora of southern USA and Mexico, in order to discover sources of diosgenin, a substance of relevant importance for the synthesis of corticoid and sexual hormones.

This short historical introduction reveals the enormous potential the South American continent has as a source of medicinal plants.

South America has an area of 18,000,000 km^2 which represents 13% of the earth's total terrestrial surface. 45% of this area is sylvan ground and, therefore, an extraordinarily fertile field for the study of a prodigiously exuberant flora.

Chile and its geography

The Chilean territory is a long and narrow strip of land situated in the southwest of the continent; it stretches between the parallels 17° and 56°; that is to say, a distance comparable to the stretch between the north of the Scandinavian peninsula and well into Libya.

Its surface is about 750,000 km^2 and its coast is 4,300 km long. The mean width of the country is only 180 km.

The northern part from the limit with Perù to the parallel 32°, is a desert with its own climatic characteristics.

The central zone extends from 32° to 40°; it is characterized by a rich agriculture and has a mediterranean climate. It is fundamentally here where the medicinal flora is found.

Finally, from 42° to 56° to the south we find a region with a very dismembered coast, with an enormous number of islands. Its climate is cold and rainy.

Chile and its medicinal flora

The chemical study of the Chilean flora started in 1948 at the Universidad Santa María, under the leadership of Dr. H.H. Appel. Later this research extended to 9 other groups along the country. At this time it represents the largest research branch of Chilean chemistry.

In referring to Chilean medicinal plants and their commercial importance, I will cite two specific cases: *Peumus boldus* (Monimiaceae), and *Rosa aff. rubiginosa* (Rosaceae).

Peumus boldus

P. Boldus is an evergreen tree 3 to 6 metres high, with dark, rough and fragrant leaves and white flowers. Its geographic distribution reaches from Coquimbo to Osorno. Its infusion has long been used, especially for liver aliments and as a digestive tonic.

Warnat [1] isolated between 1925 and 1926 an aporfinic alkaloid, boldine, and established also its structure. Later studies by Späth [2] and Schlittler [3] confirmed this. Kupchan *et al.* [4] succeeded in synthesizing it in 1976 (Fig. 1).

Commercially, the export of leaves and bark of *P. boldus* reaches an average of 800 tons per year. These products go mainly to the European and Latin American markets (Fig. 2).

Rosa aff. rubiginosa

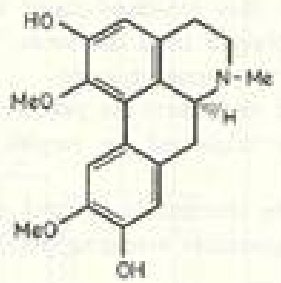
In recent years the study of this species of the Rosaceae family has acquired a very special relevance.

R. rubiginosa is a shrub with thorny stems 1 to 2 metres high, which grows as weeds between Talca and Llanquihue, and in particular in the Biobio region, where it covers an estimated 15,000 hectares, with a production of 400 kg per hectare.

Its fruit is used in the manufacture of marmalades and jellies, with a national demand of 1000 tons per year.

Berger [6] in 1952 established the presence of ascorbic acid in its fruits, with a yield of up to 500 mg/kg.

In 1985 and 1986 Valladares *et al.* [7] published their research results



Boldine

Fig. 1 - from *Peumus boldus* (Monimiaceae).

Structure: K. Warnat, Ber. *58*, 2768 (1925); K. Warnat, Ber. *59*, 83 (1926); E. Späth, K. Tharrer, Ber. *66*, 904 (1933); E. Schlittler, Ber. *66*, 988 (1933).

Synthesis: S.M. Kupchan, Ch. K. Kim, K. Miyana, Chem. Commun., 91 (1976).

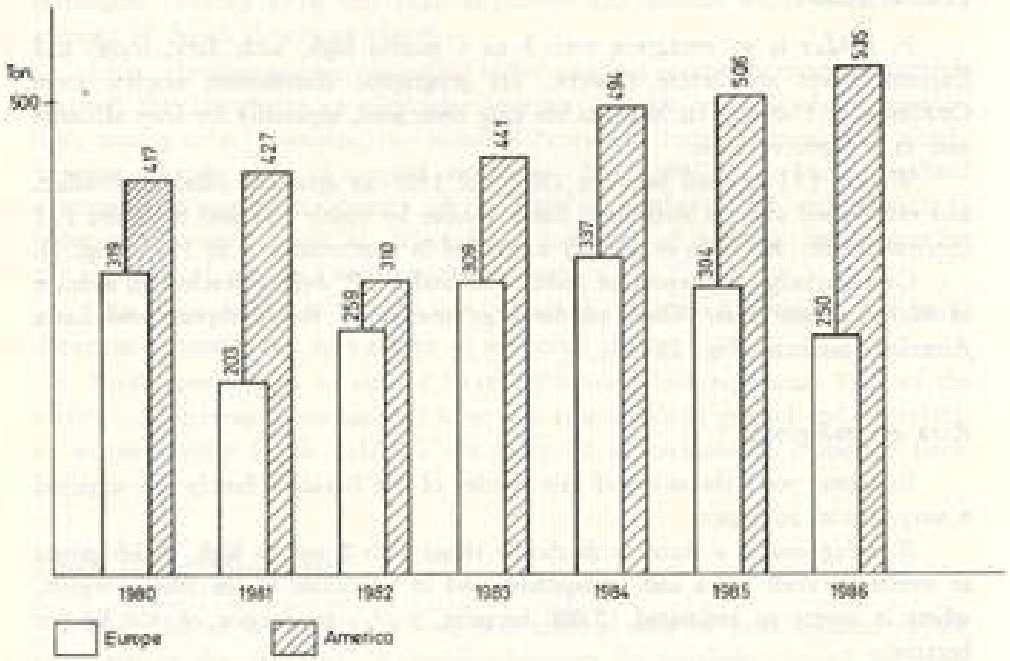


Fig. 2 - *P. Boldus Export.*

relative to the presence of oleic, linoleic and linolenic acids which were extracted from the seeds. The last two of these acids are present in a percentage of 80% (Fig. 3). At the same time they informed about the cosmetic properties of a cream made with the oil obtained from the seeds, in the treatment of patients bearing scars and lines due to premature aging.

From a clinical point of view there are positive responses in cases of hyperchromic and retractile scars originated by surgical incisions, traumatisms and burns.

Regarding its export, the demand is directed mainly to northern European countries and the USA, in quantities averaging 4000 tons per year [5] (Fig. 4).

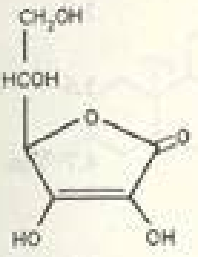
Other species

From a statistical viewpoint one can mention a few irregular exportations of some species which are not aboriginal, like *Tilia europaea*, *Matricaria chamomilla* L. and *Mentha piperita* L. These are sent mainly to the German Federal Republic and their volumes are small [5] (Fig. 5).

Oleic acid

Linoleic acid

Linolenic acid



Ascorbic acid

F. Berger, « Handbuch der Drogenkunde », Vol. III, p. 243, 1952.

J. Valladares *et al.*, An. Real Acad. Farm. *51*, 327 (1985); *51*, 597 (1986).

Fig. 3 - *Rosa aff. rubiginosa* (Rosaceae).

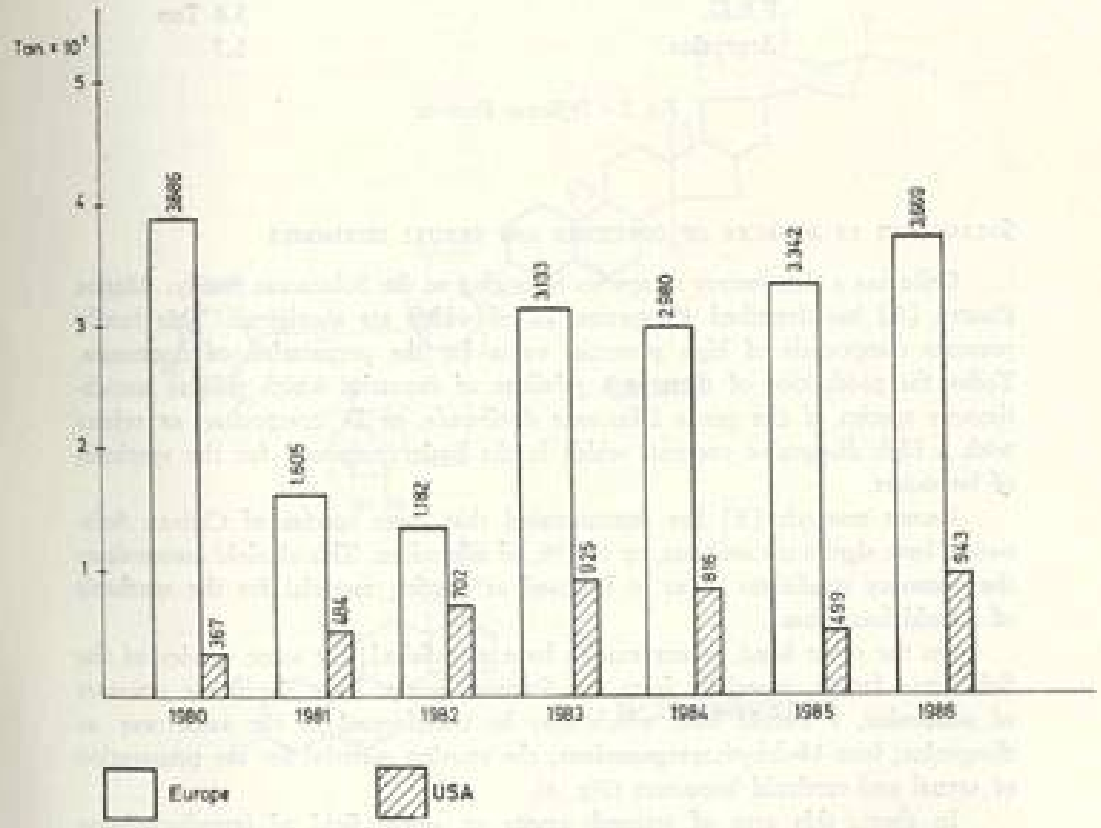


Fig. 4 - *Rosa aff. rubiginosa* Export.

1980	Tilia Europaea	
	Argentina	2.9 Ton
	Perù	0.5
	Matricaria chamomilla L.	
	F.R.G.	3.2
	Mentha piperita L.	
	F.R.G.	5.6
1981	Matricaria chamomilla L.	
	F.R.G.	4.7 Ton
	Mentha piperita L.	15.0
1982	Matricaria chamomilla L.	
	F.R.G.	3.5 Ton
	Mentha piperita L.	3.7
1983	Tilia europaea	
	F.R.G.	1.3 Ton
	Matricaria chamomilla L.	13.6
1984	Tilia europaea	
	F.R.G.	3.8 Ton
	Argentina	1.5

Fig. 5 - Different Exports.

Solanaceae as sources of corticoid and sexual hormones

Chile has a rich variety of species belonging to the Solanaceae family. Muñoz Pizarro [8] has described 48 species, 20 of which are aboriginal. This family presents compounds of high potential value for the preparation of hormones. Today the production of these is a privilege of countries which possess autochthonous species of the genus *Dioscorea floribunda*, or *D. compositae*, or others with a high diosgenine content, which is the basic compound for the synthesis of hormones.

Recent research [9] has demonstrated that some species of Chilean Solanaceae have significant amounts, up to 3%, of solasodine. This alkaloid accumulates the necessary conditions so as to be used as starting material for the synthesis of steroid hormones.

On the other hand, recent studies have established that some species of the Solanaceae family, especially from the *Solanum* genus, have significant amounts of solasonine, a steroid base which may be transformed in the same way as diosgenine, into 16-dehydropregnenolone, the starting material for the preparation of sexual and corticoid hormones (Fig. 6).

In short, this area of research opens an ample field of interdisciplinary studies which might connect botanists, agronomists, chemists and pharmacologists.

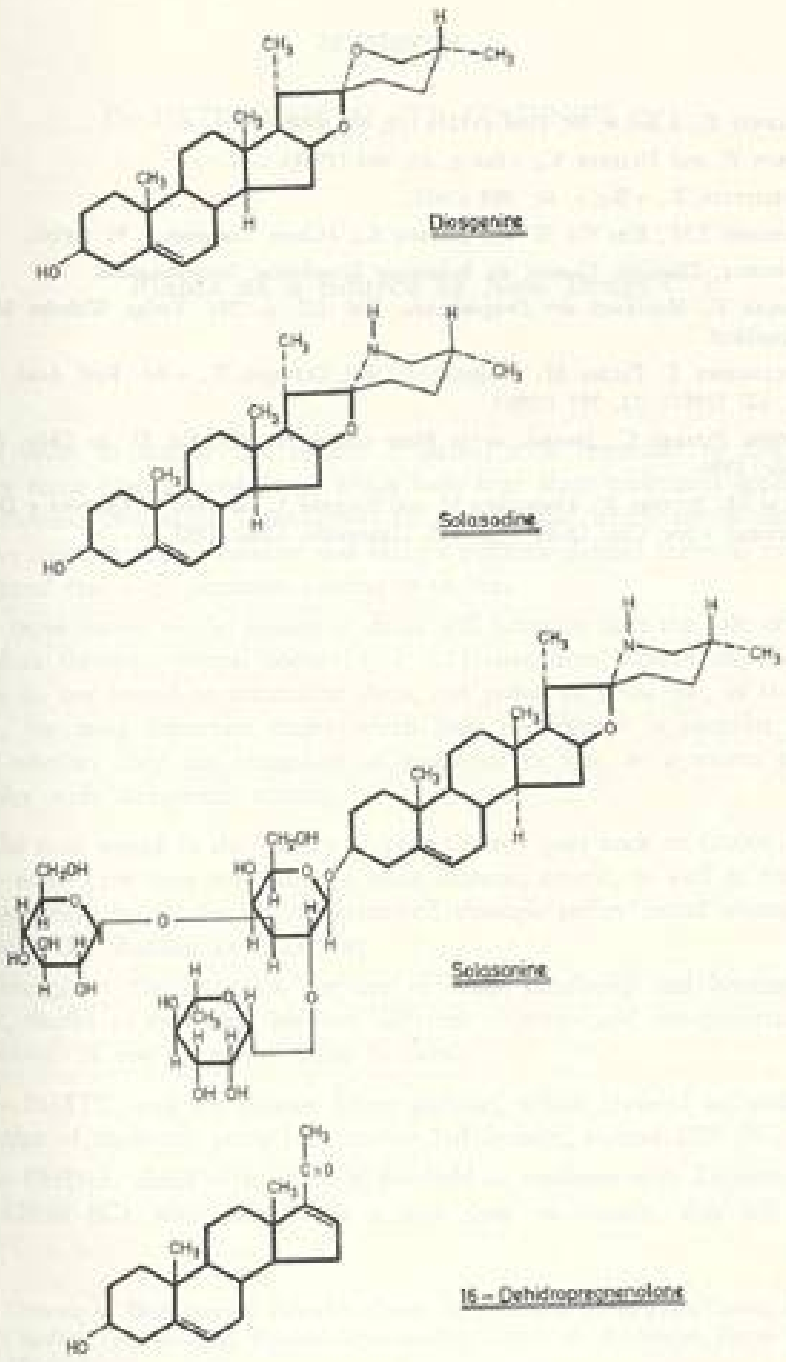

Diosgenine
Solasodine
Solasonine
16 – Dehidropregnenolone

Fig. 6

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