Cultivation of *Ginkgo biloba* L. on Three Continents

Wilhelm Schmid
Dr. Willmar Schwabe Pharmaceuticals
Karlsruhe
Germany

Jean-Pierre Balz
SCRAS
Le Muids
Switzerland

Keywords: *Ginkgo biloba* L., cultivation, drying, Good Agricultural Practice (GAP)

Abstract

Pharmaceutical products for the treatment of dementia based on *Ginkgo biloba* L. leaves represent the core business of the Dr. Willmar Schwabe group of pharmaceutical companies. Together with the French partner Beaufour – IPSEN, the group established ginkgo plantations in the US, France and China to secure a constant supply of high quality raw material. Ginkgo thrives in subtropical climates on acid, sandy and well-drained soils. The plants are cultivated in rows and are kept weed free throughout the year. During the winter plants are cut back and sub-soiling is done in the inter-rows. Depending on local climatic conditions, green Gingko leaves are harvested in July (US), August (China) or September/October (France). Leaves are stripped off the plants manually (China) or mechanically using modified cotton pickers (US and France). In a dehydration plant, fresh leaves are dried in industrial propane heated drum dryers and packed into bales. Quality management is secured by applying Good Agricultural Practices (GAP) regulations all along the production process. Plantations in France and the US are fully owned and managed by Dr. Willmar Schwabe and Beaufour – IPSEN partner companies. Initial fields were established 22 years ago and are still producing high quality raw material inspite of being stripped of leaves and cut back on a yearly basis. Two Chinese ginkgo companies were set up in the mid 90's as joint ventures with the Government of China where ginkgo leaves are produced by thousands of small-scale farmers. These joint venture companies are responsible for buying, drying, packaging and shipping of all goods. The companies are running successfully and the partners involved are gaining valuable cross-cultural experience.

INTRODUCTION

Dr. Willmar Schwabe Pharmaceuticals, founded in 1866 in Leipzig, is one of the oldest companies in Europe. As specialists for phytopharmaceuticals, this group of companies is today one of the leading manufacturers of plant-based medicines worldwide. Preparations based on ginkgo leaves are the company's major business.

On one of his numerous medicinal-plant expeditions, Dr. Willmar Schwabe came across the ginkgo tree and its pharmaceutically interesting leaves. As a result of subsequent research and development activities the first ginkgo preparation "Tebonin" was released in 1965. Indications for medicines containing the standardized ginkgo extract EGb 761® (Drieux, 2000) are disturbances in cerebral performance due to organic brain syndrome such as occur in Alzheimer's disease, e.g. deficient memory, disturbances of concentration, depressive mood, dizziness, tinnitus and headaches (Bauer, 1996).

At the end of the seventies, a continuously increasing demand for raw material led to the decision to establish the company's own plantations in France and the USA for the production of ginkgo leaves together with the French partner "Beaufour-IPSEN". In 1995 cultivation activities further expanded with the foundation of two joint-venture companies in China (Table 1).

Long-standing research into the biochemistry of ginkgo showed that relevant constituents are predominantly produced in the roots where they are translocated to the leaves. The extent of production depends on plant age. Cell cultures proved to be unsuitable for in vitro production of relevant terpenes (Balz, 1999).

AGRONOMY

Ecological Requirements

Ginkgo thrives in warm temperate to subtropical climates as prevailing in Southern Europe, the Southern States of the USA or in Eastern China. The best growing conditions are found on deep sandy and well-drained soils with pH values between 5 and 6. Additional irrigation is necessary to obtain optimal yields if rainfall is insufficient during summer months. In Central Europe, temperatures are too low for an optimal production and late frost may damage sprouting leaves in springtime.

Cultivation Techniques

Initially, ginkgo seeds are drilled in nursery fields at a density of 300,000 to 400,000 plants/ha. After two years, the seedlings are transplanted to their final site in rows with a density of 25,000 plants/ha (Table 2). In fully mechanized plantations of Europe and the US, the row cultivation technique with plants up to 1.50 m high requires specialized equipment with respect to tractors, cultivators and harvesting machines. One important feature is high ground clearance, allowing the machines to pass through the rows without damaging the trees.

Fields are kept weed-free throughout the year. The integrated weed-control concept within US and French plantations is based on shading by the crop canopy as well as the use of flame cultivation and different mechanical control systems such as e.g. the star hoe. Flaming particularly aims at controlling young annual weeds and weeds within the row. Before harvest, persisting weeds are removed manually in order to prevent contamination of stripped off ginkgo leaves. The high expense for weed control is reflected in corresponding costs which amount to 700.- to 900.- €/ha. In China, all weed control is carried out manually.

Ginkgo trees are pruned during winter and manual labor is used in China, whereas in the other plantations it is carried out mechanically. Pruning height follows a 6-year cycle taking into consideration regular rejuvenation of trees, high leaf production and the feasibility of machine harvesting. Sub-soiling of inter-rows down to a depth of 60 cm is carried out after pruning operations in compacted soils of mechanized plantations only (Table 2).

Harvesting

Depending on climatic conditions of respective sites, green ginkgo leaves are harvested in July (USA), August (China) or September/October (France). Since manual weed control is carried out simultaneously with harvesting and drying, the need for manpower increases during this period on plantations in the US and France from 52 to about 150 persons (Table 1). Leaves are harvested mechanically using modified cotton pickers. In China, leaves are hand picked involving thousands of smallholders and their family members. Yields are between 2 and 4 t of dry leaves per ha depending on site and pruning stage.

Drying

Fresh leaves are dried in propane or diesel fired drum dryers at all 3 geographical locations. After cooling dried leaves are pressed into bales of 110-115 kg. One dehydration unit produces 1-1.5 t dry leaves/hour depending on its size.

Quality Management

All operations on plantations including drying are carried out according to Good Agricultural Practice (GAP), which allows an uninterrupted “in-house” quality control from the plant in the field to the finished pharmaceutical product sent to pharmacies.

SOCIO-ECONOMIC CONSIDERATIONS

European and US plantations were established 22 years ago and are still producing

high quality raw material. One of the major challenges in these enterprises is to minimize labor input and make efficient use of the specialized and valuable machinery (Table 3). The single most demanding operation throughout the year is weed control.

In China, "Tancheng Luyuan Ginkgo Co." and Pizhou Zhongda Ginkgo Leaves Co. Ltd." are buying, drying, packaging and shipping ginkgo leaves exclusively. All cultivation is done by smallholder families under the supervision of the local Government. Since individual fields are small and labor costs low, all field work is done manually. Therefore, it is not possible to make use of the economies of scale with respect to cultivation. Prices for green leaves are mainly influenced by global ginkgo market trends and, to a lesser degree, by local production cost (Table 3). Building and keeping good relationships with Government officials is the most important precondition to a successful Chinese enterprise. Both Chinese and European partners are gaining valuable cross cultural experience.

The oldest ginkgo trees in Asia are said to be more than 2,000 years old. The oldest plants on our plantations have been cultivated for over 22 years and do not show any signs of fatigue despite the high strain caused by pruning and leaf harvesting. The medicinally active components may also confer endurance and vitality on the tree itself?

Literature Cited

Balz, J.-P., Courtois, D., Drieu, J., Reynoird, J.-P., Sohier, C., Teng, B.P., Touché, A. and Pétiard, V. 1999. Production of ginkgolides and bilobalide by *Ginkgo biloba* plants and tissue cultures. Planta Medica 65:620-626.

Bauer, R. and Zschocke, S. 1996. Medizinische Anwendung von *Ginkgo biloba* L. Z. f. Phytotherapie 17:275-283.

Drieu, K. and Jaggy, H. 2000. History, Development and Constituents of EGb 761. p.267-277. In: T.A. van Beek (publ.), *Ginkgo biloba*, Amsterdam: Harwood Academic Publishers.

Tables

Table 1. Set-up of *Ginkgo biloba* plantations on three continents.

	USA	***France***	***China***
Legal	Ltd. Co.	Société Civile Agricoles - SCA	2 joint venture companies
Physical	Plantations, each one incl. a dehydration plant		Drying plants - fields owned by smallholders
Size	450 ha	480 ha	"1.000-3.000 ha"
Production (dry leaves)	up to 1.100 t	up to 1.400 t	up to 2.000 t
Staff: - permanent	22	30	30
- temporary	50	50	200 (>50.000 for manual leaf harvest)

Table 2. Cultivation of *Ginkgo biloba* on three continents.

	USA	***France***	***China***
Arrangement	Row cultivation, up to 1.50 m high		Row cultivation
Spacing: "plants/ha"	25,000		10,000-50,000
All Year: weed control	Mechanical, flaming, manual		Manual
Spring:			
Fertilisation	Mineral + organic		Mineral + organic
Pest control	none		none
Summer:			
Irrigation	Center Pivot		Flood irrigation
Harvest	July	Sept./Oct.	August
	Modified cotton pickers		Manual
Drying	Drum dryers, propane heated		Drum dryers, diesel
Autumn/Winter:			
Pruning	Mechanised, specialised equipment		Manual
Sub-soiling	Deep rippers		-

Table 3. Socio-economy of ginkgo cultivation on three continents.

	USA	***France***	***China***
Cost			
Labor	high	high	Low
Investment	Fields, plants, drying plant		Drying plants only
Price influenced by ...	Cost and efficiency		Ginkgo market, income of farmers,
	Economies of scale!		Economies of scale on cultivation do not apply
Relationship with Government	Of some importance initially		Very important throughout
Challenges:	Weed control, Labour cost, Improve efficiency		Language barrier, Government staff turn-over, Control over cultivation technique (indirect)