Australian Government
Rural Industries Research and
Development Corporation

International Symposium on Chamomile Research, Development and Production

Presov, Slovak Republic
7-10 June 2006

A Travel Report presented to the Rural Industries R&D Corporation

by Dr Linda Falzari
Junior Research Fellow
University of Tasmania

January 2007

RIRDC Publication No 06/136
RIRDC Project No TA056-27

ISBN 1 74151 399 5
ISSN 1440-6845

I. International Symposium on Chamomile Research, Development and Production
Presov, Slovak Republic
7-10 June 2006
Publication No. 06/136
Project No. TA056-27

Researcher Contact Details
Dr Linda Falzari
Tasmanian Institute of Agricultural Science
University of Tasmania
Private Bag 54, HOBART, TAS 7001

Phone: +61(0)3 6226 2650
Fax: +61(0)3 6226 7609
Email: Linda.Falzari@utas.edu.au

In submitting this report, the researcher has agreed to RIRDC publishing this material in its edited form.

RIRDC Contact Details
Rural Industries Research and Development Corporation
Level 2, 15 National Circuit
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6272 4819
Fax: 02 6272 5877
Email: rirdc@rirdc.gov.au.
Web: http://www.rirdc.gov.au

Published in December 2007
Printed on environmentally friendly paper by Canprint

Contents

Executive Summary

Chamomile, (*Matricaria recutita* (L.) Rauschert) is a crop widely used as a dried herb infusion tea and steam-distilled to produce blue chamomile essential oil. A feasibility study, supported by RIRDC in 1999-2003 showed it to be a potential new crop for Tasmania. This current report presents the outcomes of attendance of the I. International Symposium on Chamomile Research, Development and Production, in Presov, Slovak Republic, 7 – 10 June 2006 and excursions to examine chamomile production and processing in the Presov area.

The symposium provided much scientific information on the history, pharmacology, breeding, agronomy and quality assurance of chamomile and its end-products. The proceedings of the conference will be published in an *Acta Horticulturae*.

Much of the detailed, practical information on chamomile production was collated from the post-symposium excursions. The descriptions of these cultural systems, along with the previously published research in the feasibility study, should provide sufficient basis for local growers to establish a chamomile crop in Tasmania.

Itinerary

June 4-6	Travel from Hobart, Australia to Presov, Slovak Republic
June 7-9	Attendance at the Chamomile symposium at the Presov University
June 9	Group excursion to Biovex Ltd, Michalovce to observe chamomile post harvest handling facilities
June 10	Group excursion to Agrokarpaty Ltd, Plavnica and Calendula Co., Nova Lubovna to observe large-scale cultivation, post harvest handling and steam-distillation of chamomile
June 12	Private excursion to Presov University fields and Vúrv Piestany plant breeding station
June 13	Private excursion to Calendula Co. and Biovex Ltd for further detailed discussion of the Slovak chamomile and medicinal plant industry.
June 14	Meeting with Assoc. Prof. Ivan Salamon with regard to herbicide use and general agronomic techniques in chamomile production
June 15	Visit to molecular biology laboratory, Presov University
June 16-18	Travel Presov, Slovak Republic to Hobart, Australia

Travel Report

Primary purpose of travel

The primary purpose of the travel was to gather information of significance to the establishment of a chamomile herb and extract industry in Tasmania. The key event was attendance at the I. International Symposium on Chamomile Reseach, Development and Production, in Presov, Slovak Republic, 7th-10th June 2006.

Chamomile (Matricaria recutita (L.) Rauschert is a potential new crop for Tasmania. RIRDC supported a three year project to assess the feasibility of and the production methods for this crop, beginning in 1999. The results of this research, published in 2003, indicated that chamomile should be a viable industry in Tasmania. A recommendation was made that either of the varieties Bona or New Bona produced by Dr Ivan Salamon, (conference convenor), would be suitable for Tasmanian production. Some obstacles to chamomile production were identified, including difficulties in establishing the crop in the first year and low extraction efficiency of oil using the currently available commercial distillation technology.

The Symposium provided the opportunity for presentation of these Tasmanian findings to international experts in chamomile production and to obtain feedback relevant to this industry. In addition the trip provided the opportunity for discussion with international experts and traders of chamomile, including Dr Ivan Salamon, conference convener.

Major achievements/findings of the travel

Much information was gathered on the technology and markets for chamomile and on the pharmacological products that can be produced from this crop. Most of this was gathered during the practical and post symposium phase of the travel. The symposium itself was a valuable source of scientific information on the use of chamomile as a medicinal plant.

The symposium covered many areas of chamomile research and papers by each of the presenters will be published in an Acta Horticulturae, due to be released circa September this year. The presentations fell under several themes: the pharmacology and active constituents of the products; breeding and available varieties/cultivars of chamomile; cultivation and agronomic practices including mechanized harvesting in various countries and regions; and quality control/quality assurance of the end products.

Pharmacology and active constituents of the products

Evidence was presented by several speakers, documenting the use of chamomile as a medicinal plant from many centuries BC. Many modern pharmacopeias from around the world include references to chamomile. Much of the current research on chamomile and other medicinal plants is centered on determining which of their chemical components are pharmacologically active and on the mechanisms of this activity. Many of the speakers presented evidence documenting the biological activity of chamomile oil and/or its individual components. The components in chamomile essential oil commonly accepted to have the greatest therapeutic activity are alpha-bisabolol, chamazulene and the en-in-dicycloethers. Other components also attributed with activity are apigenin, luteolin, quercetin and guajazulen. It is accepted that the entire chamomile complex is likely to be more effective than preparations of purified, individual components. Dr Kobayashi presented some of the first evidence for biological activity of bisabolol oxide A in an experiment studying the itch-scratch cycle of chemical induced dermatitis in mice. The literature giving scientific evidence for accepting the truth of folk-medicine should form the background to future management of the production of chamomile products and the associated quality assurance and quality control procedures.

Biodiversity, breeding and available varieties/cultivars of chamomile

Much of the world production of chamomile is harvested from wild or unselected populations and is hand harvested by low-cost labour. With the higher labour costs associated with more developed economies, including Australia, there is the need to cultivate and mechanise production. In addition, plant breeding and selection has been driven by a greater understanding of the nature of the pharmacology of the product and determination of the biological activity of its chemical constituents. Current trends are for increased production of medicinal plants, including chamomile, through fully mechanized cultivation systems based on varieties bred or selected for a high content of essential oil, which in turn has a high content of active components, principally alpha-bisabolol, chamazulene and en-dicycloether.

The varieties discussed during the symposium were Manzana, Bodegold, Goral, Bona, New Bona and Lutea. The Tasmanian feasibility study mentioned above, tested the varieties Bodegold, Bona and New Bona.
The variety Manzana originated from induced muations of a wild population of Spanish chamomile. It is of the alpha-bisabolol chemotype and could be a useful variety for Tasmania, but a seed-source would need to be located.
Bodegold is a population variety of the bisabolol oxide chemotype. It produces high yields of flowers and is produced commercially as a tea variety. There are markets to which it would be suited but since Tasmania's target market demands the alpha-bisabolol chemotype, this variety would not be suitable. This information is in agreement with the results of the feasibility study.
Goral is a tetraploid variety, with large flowers but produces oil with 65% bisabolol oxide and 35% alpha-bisabolol and is therefore unlikely to find a place in Tasmanian production.
Bona and New Bona are both products of the Slovakian breeding program and were released in the late 1980's. Both are homogeneous varieties of the alpha-bisabolol chemotype, both produce oil high in chamazulene and both would be suitable for the intended Tasmainan industry. Discussion at the symposium suggested that there was no significant advantage of one of these varieties over the other. Bona is commonly grown in Slovakia and other European production areas and seed of this variety is therefore more readily available. This is a diploid variety, with small compact anthodia and high oil yield. It is one of the preferred varieties for steam distillation to produce blue chamomile oil.
The variety Lutea was released in the early 1990's and is a tetraploid variety of the alpha-bisabolol chemotype, producing oil with ~45-50% alpha-bisabolol and also high levels (~24%) of chamazulene. It has a high oil yield (1.0-1.2%) compared with Bona (~0.95%). It is adapted to an arid environment but appears to be variety worthy of testing in Tasmania.

Cultivation and agronomic practices including mechanized harvesting in various countries and regions

The intensity of chamomile production varies from the harvesting of wild-growing flowers by indigenous, itinerant workers such as the gypsy population of the East-Slovakian lowlands; to low-intensity cultivation in Egypt where it is hand-weeded and later hand-harvested by children; to fully mechanized, large-scale cultivation as in Germany and some areas of Slovakia. Many countries seem to have a mixture of highly intensive cultivation in addition to labour-intensive, non-mechanized cultivation or wild harvesting. The trend in most areas is for an increase in the level of mechanization, which would be the necessary system in Tasmania. Dr M. Pajic produced figures to show that either 1600 people or 24 combine harvesters are required to pick the yearly chamomile crop in Serbia.
Most mechanized producers of chamomile utilize similar methods, have the same difficulties and are aiming for similar quality end-products. Varieties grown, as described above, differ with production regions with a tendency for the diploid varieties to be favoured for distillation and the tetraploid varieties for tea production. However, since most producers of tea use steam-distillation to value-add to their waste product, this scenario is not strictly adhered to.
Climates in chamomile producing areas tend to be similar, though harsher than the Tasmanian climate, i.e. somewhat hotter in summer and colder in winter than but with no substantial differences which would rule out the Tasmanian environment.

Much of the detailed information relating to the agronomic factors involved in chamomile production was gathered in the post-symposium excursions. A summary of the general methods used in Slovakia and details of the recommendations for the Tasmanian industry will be presented later in this report.

Quality control/quality assurance of the end products

One issue of importance to chamomile quality assurance is its ability to hyperaccumulate of heavy metals. Some of the essential oil components of chamomile are able to bind or chelate heavy metals and allow chamomile to grow in soils toxic to other plants. Accumulation tends to be highest in the roots but is also in the shoots and aerial parts of the plant. Prof. Dr E. Masarovicova highlighted three implications of this in her presentation. The first is the need for quality control procedures to test chamomile for heavy metal content if the crop is grown in areas that are, or could be, contaminated by heavy metals. This is particularly important if the crop is to be used as an infusion tea or otherwise ingested. It is perhaps of less importance where the crop is to be distilled since the heavy metals should remain in the marc. The second implication is that chamomile can be used as a phytoremediation tool in the cleanup of contaminated sites. The plants can be used to accumulate e.g. cadmium or salt and then removed from the site. The third implication is the use of chamomile for phytofortification to treat e.g. selenium deficiency in human populations where traditional fortification through medication is difficult. This point also has important ramifications for animal feed industries.

Another quality assurance issue for therapeutic goods, brought to attention at the symposium is that, within the European Union, risk assessment and safety are more important than effect or efficacy. This generalisation is probably true for most countries, i.e. it is more important that the products consumed are “safe” and inflict “no damage” than that they actually perform a therapeutic function. That is not to say that effect and efficacy are not important, but “safety” is of utmost importance. To this end, quality assurance protocols and quality control procedures must be in place to ensure that the product is not contaminated by allergens or toxins, arising from biotic factors such as the presence of weeds or insects, or abiotic factors such as pesticides, soil contamination etc. This has implications for the growing organic production industry where the use of mulches and manure based fertilisers can lead to excessive microbial loads on the crop. Prof. L. Craker discussed some of these issues in his presentation and advised that in the USA there is increasing production of crops, including medicinal plants in hydroponic systems that avoid soil contamination of the crops and therefore the need for post-harvest cleaning.

Cultivation system for Chamomile as it is in Slovak Republic

Chamomile is planted in a crop rotation system to minimize weed problems. Generally either red clover or wheat is used in the rotation prior to chamomile. Clover is particularly good because it adds a natural source of nitrogen to the soil. Post harvest of these crops, the stubble is incorporated into the soil by ploughing. Treflan is then applied to the soil and harrowed to incorporate the chemical. After three days the chamomile seedbed is worked to a very fine texture and then tines are used to produce a series of narrow furrows. The seed is broadcast to produce an even cover across the paddock and not sown in either rows or beds. The use of rows with associated crop free inter-row spaces allows for the establishment of a weed population within the crop.

The crop is sown when there is an expectation of rain within the following 3-5 days. This gives good germination within 10-12 days. Once the crop has formed rosettes with several adult leaves it is resistant to frost and even to a covering of snow. It requires a minimum of 6°C in order to grow. Seed is sown at a high density, approximately 2.5kg/ha as a high stand density produces plants with fewer leaves and a greater proportion of flowers. The crop thus produced also has greater synchronicity of flowering time, alleviating the need for more than two harvests. The cost of the seed is likely to be around $US 100-120/kg and must be certified as clean seed with no weeds and 80-90% germination. It is particularly important that the weed *Matricaria inodora* is not introduced to Tasmania, as this is a particular problem in chamomile crops Slovakia and other European countries.

Herbicides which could be considered for use to control weeds within chamomile crops include, Gesagard 80 (1.2 kg/ha), Lontrel 300 (0.4L/ha), Fusilade Super (4.0L/ha), Afalon disp. (1.2 L/ha), Duplosan DP (1.5L/ha) and Duplosan KV (1.5L/ha). Appropriate permits would need to be obtained and it is suggested that trials of these products under Tasmanian conditions be undertaken. Consideration of residues in the products, particularly medicinal teas, is of particular importance.

The crop is grown in the Slovak Republic with no additional fertilizer, only that which remains from the preceding clover or wheat crops. No irrigation is used but light rainfall is common, particularly early in the growing season. Soil moisture is also high at this time from the melting snow.

Harvest of the crop begins when approximately one third of the disc florets are open on one third of the flowers. A second harvest removes the remainder of the crop.
Harvesters in Slovak Republic have the cutting head at the front of the machine and therefore the crop is picked before the wheels pass over the plants. The harvesters tested in Tasmania were carried behind the tractor and therefore the crop was planted in beds to avoid crushing the crop during harvest. This may be a problem if the crop is sown be broadcasting.
A further difference between the Slovakian harvesting heads and those previously tested in Tasmania is the presence of cutting knives, which slice the flowers from the stems during harvest. With a good operator and a well-maintained machine, the Slovakian system allows for a very clean pick and very little post-harvest handling to produce a premium quality product.
Post-harvest, where necessary, the crop is passed through a double rotating barrel that separates the premium material (flowers with very sort stems) from the remainder of the crop. The waste material from this process can be used for steam-distillation to produce blue chamomile oil.
The premium crop is then dried. Several types of dryers are used from small, fixed beds with air circulating from below to a large hop kiln where the flowers are moved through on a conveyor belt. The important points to note are that drying must commence as quickly as possible after harvest, if the quality of the crop is to be maintained. Secondly, chamomile flowers have a high respiration rate and produce very large amounts of metabolic heat. This heat must be dissipated quickly to prevent breakdown of the product or at the extreme, spontaneous combustion. To this end, cold air is often circulated through the flowers in the first instance. As the moisture content falls, warm air is applied to continue the process more quickly. The depth of the flowers in the dryers is also controlled to ensure that air flower through the crop is maintained. Optimisation of the packing depth of the flowers is critical since there is a compromise between drying the largest amount of material as possible, with minimum resources but also drying the flowers as quickly as possible to since delays reduce the quality of the final product through biochemical changes to the oil composition.
Post drying, if necessary, the crop may be passed through a de-stemming machine to increase the quality of the herb product for the tea market. The aim is to produce a crop of flowers with stems 2cm or less and with no green material present. Waste material from the de-stemming process tends to include a high proportion of ligulate florets and can be extracted to give product that is high in apigenin.

Benefits/significance to the person funded and his/her work

The greatest personal benefit to arise from this travel was the establishment of a network of researchers working in similar fields and of producers and manufacturers who can and did provide advice on the establishment of production in Tasmania. The companies that were specializing in the production of chamomile herb and oil were also producers of chamomile seed and therefore often willing to make available production information with the view to becoming suppliers of high quality seed to the emerging Tasmanian industry.
It is expected that in the future, collaborative research could be undertaken, particularly between Dr Ivan Salamon, University of Presov, and the local Tasmanian industry. This research could involve testing of the output from the Slovakian breeding program under Tasmanian conditions but also perhaps input into that breeding program using micropropagation techniques skills that are already established at the University of Tasmania. Further collaboration may be possible in the development of other medicinal, phytotherapeutic or nutraceutical crops.
Contacts have also been established with researchers in Poland, Germany, Serbia, Chile, USA and the Chech Republic.

Benefits/significance to the rural industry

The outcome of the information gathering is positive for the production of chamomile in Tasmania. A current estimate of the size of the chamomile herb market in Australia is 50 tonnes per annum, almost all of which is currently imported from Egypt. This is used in the local tea industry but also in the production of extracts. The bulk of this supply is not of high quality but there is the opportunity to supply some high quality product. With good quality assurance protocols and a reputation for reliable supply, Tasmania should be able to break in to this market and replace part of this import with local production. There may be some difficulty with price due to the low labor costs associated with the

Egyptian production but this should be able to be offset by reduced transportation costs and full mechanization of the local production.
There is also the opportunity to supply blue chamomile oil of a high alpha-bisabolol chemotype. Oil of this type currently trades at an estimated $US1300/kg.
A new and growing market for chamomile is in animal feed, particularly horse feed where the phytonutritional value of chamomile is used (anecdotally) as a calmative and for treating leg muscles and tendons.

The emerging Tasmanian industry will benefit from the contacts established with the Slovakian producers who have vast experience in large-scale chamomile production and who view Tasmania as a consumer of their high quality chamomile seed.

Recommendations to RIRDC and industry arising from the report

From the information gathered during the travel, it appears that the domestic Australian consumption of dried chamomile herb for tea has grown in the last few years and is in the order of 50 tonnes per annum. It is suggested that the local producers conduct their own investigation of this market to substantiate these figures. In addition, consideration should be given to the production of blue chamomile oil as the price for this commodity appears to be double the figure used in the original Tasmanian feasibility study. A further market for investigation is in animal, particularly for horses.

It is recommended that the local industry begin production with a crop, around 10ha in size. This will provide around 2-3 tonnes of premium quality dried flowers plus material for distillation. This should be sufficient material to establish domestic markets for Tasmania's product without exposing the grower/s to an unacceptable level of commercial risk. The crop could be spread between a small number of growers, with properties within a small geographical region. It is recommended that they adopt the protocols described for the production of chamomile in Slovakia. Some investment in post-harvest infrastructure, such as sieving and drying equipment, will be required to produce a premium quality herb product for tea.

Bona should be the variety chosen for this initial production, since this was shown to be suitable in the previous Tasmanian study. Seed for this variety is readily available from the Slovak Republic, provided orders are placed prior to or during the Slovakian harvest season, *i.e.* June/July. The implication is then that seed for a Tasmanian spring sowing need to be placed 12 months in advance.

Future research, requiring support from both the local industry and RIRDC should test the variety Lutea, as this has greater yield potential than Bona but is intended for arid climate production. It is not clear how it will behave in the Tasmania environment.

Suggested dissemination of information in the report

A copy of this report will be given to each of the industry partners who assisted with funding for the travel. It is also intended that a slideshow presentation of the photographs from the excursions will be copied to CD and distributed to the local industry representatives. A synopsis of the conference will also be included, although the full proceedings of the conference will be available after publication of the *Acta horticulturae* circa September 2006. Much of the knowledge acquired during the travel will be passed on through the usual regular meetings and discussions that take place with the local industry representatives.