IENICA

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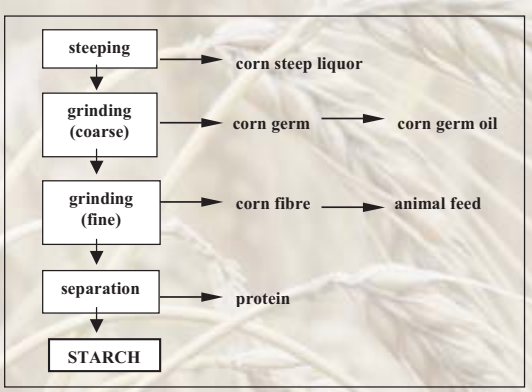
Non-Food Applications Of Starch

Starch production and utilisation varies a great deal between the different countries of Europe. The major crops for starch production are maize, wheat and potato.



Biorefinery of maize for starch

There are many potential uses of starch:

- unmodified starch can be used in the pharmaceutical, paper, mining and building industries
- it can be modified and converted to starch derivatives, isosugar, high fructose syrup and ethanol

Examples of starch based products:

Flocculation agents

The natural polymer of starch can be made suitable for partial or complete substitution of synthetic polymers in certain fields of application, by chemical modification. Flocculants are water soluble, ionic polymers ("polyelectrolytes") of high molecular weight, that can be used in the clarification of water and in wastewater treatment. They promote the sedimentation and filtering of colloid size particles in aqueous suspensions by binding them via charge neutralising and bridge forming mechanisms. There are two types of flocculants, anionic (starch phosphates) and cationic (starch ether derivatives).

As a promising initial result of a Hungarian project, a novel product has been developed that can be used in the treatment of drinking water as a coagulant aid, together with Al- or Fe-salt coagulants. This flocculant is a starch phosphate with a very low P-content (0.6%). Industrial scale experiments have shown that starch-based flocculants are suitable for the substitution of synthetic agents.

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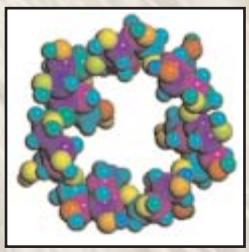
Cyclodextrins

Cyclodextrin is a crystalline, water soluble, cyclic (α type) and non-reducing oligo saccharide that is built from 6-8 glucose molecules. It is used for the elimination of odour and taste materials and the solubilisation of almost insoluble materials. Although these properties are well known, the high price of cyclodextrin hampers its utilisation. However,



Cyclodextrine

recent developments in enzymatic processes have decreased the price and other uses are now emerging. Currently, there are 5 companies worldwide with an annual cyclodextrin production exceeding 1000 tonnes. Cyclolab, for example, is a research institute in Hungary working with pharmaceuticals, cosmetics, food and agrochemicals, plus the environmental and analytical applications of cyclodextrines. Cyclolab produces commercially non-available derivatives for research and analytical applications. *For more detail see: http://www.cyclolab.hu*

New market outlets for starch in France

- Adhesives and glues - for manufacture of corrugated paperboard
- Textiles - for preparation of weaving production lines and printing cloth plastics
- Building and construction - additives, binders, anti-freeze and retarding agents for concrete (gluconic acid)
- Lubricants - in association with vegetable oils for manufacture of biolubricants
- Agrochemicals - binder in the make-up of fertilizers, modified starch allowing controlled release of phytosanitary products by encapsulation, seed coatings
- Super-absorbent products - grafted starches that retain up to 1,000 times their weight in water: in disposable nappies, talc substitute, root coating in semi-arid zones

The BIODECAP company, in France, has instituted a new use. A vegetable polymer obtained from the extrusion of a special wheat grain is used to strip painted surfaces, particularly airplane bodies. This stripping product is biodegradable and presents no toxicity or hazard problems to the environment or people. *(http://www.biodecap.com)*

Wheat grain polymer

(http://www.biodecap.com)

The French AGRIPACK company produces packing material from maize starch. The beads obtained are spherical and calibrated at approximately 15-20 mm in diameter. A 20% share of this market could be supplied by industrial crops on 2,000 ha of set-aside.

AGRIPACK packaging material from maize starch

(http://www.agripack.net)

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Starch Production and Utilisation of Some European Countries

Country	Raw material	Amount	Products and industries	Companies
Belgium	- Rice		pharmaceuticals and cosmetics; adhesives; paper/ board; packaging; wood, plaster and wallpaper; flooring	Remy Industries http://www.remy-industries.be
Poland	- Potato - Domestic wheat - Imported corn	half of the whole production of EU-15	paper, carton and board; adhesives, briquetting, glass fibres sizing; finishing agents /yarns for textiles, protective colloids for mining; filler to produce biodegradable plastics	Starch and Potato Products Research Laboratory clpz@man.poznan.pl, www.clpz.poznan.pl
Lithuania	- Potato - Maize	2 400 t/year (dried starch, 2000)	cardboard; paper, textiles and pharmaceuticals; labels; glues; cationic starches for waste water treatment (Kaunas University of Technologia)	AB Ambraziskiu krakmolas (potato) Antanava F. (potato & maize) AB Klaipedos kartonas
Sweden	- Potato: - Wheat: - Non-food:	63 000 t/year 10 000 t/year 50 000 t/year (industrial use)	cationic starches for paper; cationic oxidised products for surface sizing; wet end; surface and corrugating applications; mining, chemicals and adhesives; biodegradable plastics	Lyckeby Stärke http://www.lyckeby.com
France	- 46% maize - 44% wheat - 10% potato	2.45 Mt/year (2000, 2001) 47% food stuff 53% non-food	recycled paper; corrugated board, raw material for fermentation; detergents; paints; adhesives; nappies; packaging materials; surfactants	Agripack: www.agripack.net Biodecap: www.biodecap.com Seppic: www.seppic.com
Hungary	- Maize	300 000 t/year 10% non-food (61% paper, 39% pharm. and textile industry)	paper and pharmaceuticals; glucose; maltose; isosugar; high fructose syrup; ethanol as solvent; glue; textile and paper industry; flocculation agents, cylodextrines	Hungrana Starch and Isosugar Manufacturing and Trading Co. Ltd., Cyclolab Ltd. http://www.cyclolab.hu

Plants For Pharmaceuticals

Low quantities of secondary metabolites frequently play a crucial role in a plants' physiology (e.g. as protectants), but they can also be very valuable to humans, as pharmaceuticals, diet additives or cosmetics. These compounds often show complex structures and their biosynthetic pathways are very complicated and difficult (or even impossible) to copy in a laboratory. It is generally accepted that nature offers a larger number of active structures and associations than the most sophisticated databases of synthetic structures and about 25,000 species have been utilised in phytomedicine. It is estimated that two thirds of current medicines have a vegetable origin. The popularity of herbal medicinal products has continuously increased. In 2000 the world market for these products was US $60,000 million. In Europe almost 75% of the market is in Germany and France.

Calendula officinalis

Problems, Tendencies and Priorities

Research and Development: The identification and screening involved in discovering new products requires a large number of tests to be carried out, involving a high level of IT and robotics. Isolation and characterisation of the components is necessary to improve the composition of the extract, by increasing the active product concentration and reducing the content of toxins or inhibitors. Genetic modification could be used to achieve this. Process operations should also be reproducible and traceable.

Production of plant material: Herbal products can be obtained from wild flora or cultivated plants. The trend is to replace herbs picked from the wild with cultivated species, selected for their active content. Activities in plant breeding, domestication, crop technology, harvest methods and post-harvest treatments are being developed.

Regulation: As well as national ones, there are several international regulation bodies i.e. the European Pharmacopoeia of the Council of Europe; the European Agency for the Evaluation of Medicinal Products; the World Health Organization and the directives of the European Council. Herbal remedies have more severe requirements than food supplements, similar to those required for new drugs as medicines. They are authorised to be put on the market by the National Medicines Agency, providing they fulfil EU requirements. A simplified authorisation procedure could only be used for traditional remedies which have been used for a minimum of 15 years in the EU. A guideline on good sourcing practices should also be considered.

Plants for Pharmaceuticals in Romania

Romania, due to its geographical position, diverse relief and favourable climate is home to over 3600 species of higher plants, of which over 700 are known to be medicinal. Agronomist researchers have succeeded in creating 28 Romanian varieties of plants and establishing cultivation technologies for about 50 species, of which the best results have been obtained with:

Calendula officinalis L., *Carum carvi* L., *Coriandrum sativum* L., *Cynara scolimus* L., *Foenicullum vulgare* Mill., *Lavandula angustifolia* Mill., *Matricaria chamomilla* L., *Mentha piperita* L., *Mentha crispa* L., *Pimpinella anisum* L., *Plantago lanceolata* L., *Salvia officinalis* L., *Sylibum marianum* L., *Sinapis alba* L., *Tagetes patula* L., *Thymus vulgaris* L.

Lavandula angustifolia

The area cultivated with medicinal and aromatic herbs is approximately 20,000 hectares per year, producing 12,000-15,000 tonnes of dry vegetable material. Approximately 155 varieties of medicinal and aromatic plants are also collected from wild flora (750-850 tonnes per year).

R&D studies regarding obtaining and characterising herbal pharmaceuticals are carried out at the National Institute for Chemical Pharmaceutical Research and Development in Bucharest and at the Faculties of Pharmacy belonging to the Universities of Medicine and Pharmacy in Bucharest, Iasi, Cluj, Targu Mures. Producing new herbal pharmaceutical preparations begins with the popular use of plants with healing properties, or with structure-activity relationships regarding the chemical components of plant extracts. A recent example is a new herbal antiulcerous product containing flavones as inhibitors of histamine synthesis, polyphenols and polysaccharides as anti-inflammatory, anti-microbial and adhesive healing agents.

Products obtained in Romania from medicinal and

aromatic plants are classified as:

- vegetable products from leaves, flowers, herb, seeds, fruit and roots, which are components of teas used as adjuvants in the prevention therapy of some diseases
- extracts, bioactive complexes and substances isolated from herbs to be used in the pharmaceutical industry (formulated as tablets, capsules, syrups, ointments, gels)
- essential oils useful in the pharmaceutical industry

On a production scale, herbal products are obtained by small and medium companies, which make efforts to comply with the GMP (Good Manufacturing Practice) requirements.

Herbs and Medicinal Plants in Hungary

According to the Hungarian Pharmacopeia (VII Ed.) and other regulations, 214 plant species are being sold. These represent approximately 180-200 domestic plant species; about 50-60% of these herbs are native to Hungary. The annual domestic production of dried plant materials is 35,000-45,000 tonnes. The most important cultivated medicinal plants are: *Sinapis alba* L., *Brassica nigra* L., *Carum carvi* L., *Foeniculum vulgare* Mill., *Silybum marianum* L., *Coriandrum sativum* L., *Pimpinella anisum* L., *Anethum graveolens* L., *Majorana hortensis* L., *Melissa officinalis* L.

The most important collected medical plants growing wild are: *Rosa canina* L., *Aesculus hippocastanum* L., *Equisetum arvense* L., *Urtica dioica* L., *Achillea millefolium* L., *Solidago gigantea* Ait., *Hypericum perforatum* L., *Viscum album* L., *Sambucus nigra* L., *Taraxacum officinalis* Weber. Approximately 120 species are collected resulting in 10,000-15,000 tonnes of dried material per year. Plants which are processed industrially for pharmaceuticals are poppy *(Papaver somniferum* L.*)*, rye (ergot), woolly foxglove *(Digitalis lanata* L.,*)*, and pumpkin *(Cucurbita pepo* L.*)*.

For Hungarian farmers who grow medical plants and herbs it is not easy to compete with western Europe and the world market, although the quality and quantity of some herbs is much higher than in the other supplier countries. Since the beginning of the 20th century Hungarian camomile has become famous and is called "Hungaricum", a drug with outstanding quality. Approximately 15,000 tonnes of drugs are exported; half of this to Germany. Other important importer countries are Austria, The Netherlands, Switzerland and Italy. Due to the growing interest in natural and fertiliser-free products, more and more 'biofarms' cultivate medicinal plants and herbs of higher quality but lower productivity. The main barrier to further development is currently the lack of funds and governmental financial assistance.

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Forthcoming Industrial Crops Events

15-16 May 2003
IENICA Regional Seminar: Non-Food Crops in Southern Europe and the Mediterranean: From Agriculture to Industry
Bologna, Italy
Email: congressi@avenuemedia.it

16-17 June 2003
NAROSSA: 9th International Conference for Renewable Resources and Plant Biotechnology
Magdeburg, Germany
Email: info@oehmi-consulting.de

11-12 Sept 2003
NAROTECH: Materials from Renewable Resources Supported by IENICA
Erfurt, Germany
Email: vogel@messe-erfurt.de

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