



# IENICA



## Interactive European Network for Industrial Crops and their Applications

Newsletter number 8

June 1999

The IENICA summary report on potential and constraints for non-food crops in Europe is in preparation and will be submitted to the European Commission this summer. A comprehensive volume of data on the status of non-food crops in Europe has been prepared by the partners of the IENICA project in each member state and this will be collated into a single summary report for the EU. Individual National reports will be included as annexes to the main report, and there will be overviews for the Scandinavian and Mediterranean regions. Check the IENICA website for details.

The summer schedule of IENICA seminars is well underway. The first seminar, **Natural Fibres Performance Forum** took place on 27th - 28th May 1999 in Copenhagen. Almost 200 people attended. Discussion centred heavily on industrial applications of natural fibres, from automotive and aircraft industries to structural and fashion items. We will post a full report of the seminar on the IENICA website shortly.

**Speciality Chemicals for the 21st Century** will take place in Valbonne, France on 16th - 17th September 1999. To receive further details of the programme, please contact Magali Rocher at ADEME, Tel: +33 (0) 2 41 20 41 20, Fax: + 33 (0) 2 41 20 42 00, E-mail: magali.rocher@ademe.fr,

**Vegetable Oils, Meeting The Needs Of Small, Medium and Large Enterprises** is scheduled to take place in Wageningen, The Netherlands on 21st - 22nd October 1999. To receive details of the programme for this seminar please contact Paul Struik, Agro Research BV, P.O.Box 430, NL-6700 AA Wageningen, The Netherlands, Tel: +31 318 653799, Fax: +31 318 651733, E-mail: paul.struik@users.tpe.wau.nl

Proceedings for all of these meetings will be published at a later date. See the IENICA website for details.

For further information on any of these events you can also contact Sarah Hugo at IENICA, Tel: + 44 (0) 1904 462259, Fax: + 44 (0) 1904 462029, Email: s.hugo@csf.gov.uk. Information on all of these events is available on the IENICA website events page: <http://www.csf.gov.uk/ienica>

In the UK the Ministry of Agriculture's Alternative Crops Unit, set up in 1994, has recently been given the new title "Agri-Industrial Materials (AIMS)". This reflects the switch in emphasis from finding alternative uses for set-aside land to concentrating on new markets and commercial opportunities for crop-derived raw materials.

### Forthcoming Industrial Crops Events

21 - 25 June 1999

**5th International Conference on Frontiers of Polymers and Advanced Materials (ICFPAM)**  
Poznan, Poland.

Contact: Institute of Natural Fibres

Tel: (48) 61 822 48 15

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<http://www.iwn.inf.poznan.pl/~icfpam>

24 June 1999

**The Industrial Applications of Bioplastics**

Bonn, Germany

Contact: Mrs B. Pullens de Witt

Europoint BV

Tel: + 31 30 6933489

Fax: + 31 30 6917394

Email: info@europoint-bv.com

28 - 29 June 1999

**2nd International Wood and Natural Fibre Composites Symposium**

Kassel, Germany

Contact: Mrs. Dipl.-Ing. I. Mildner

Tel: + 49 561 804 3674

Fax: + 49 561 804 3692

Email: imildner@hrz.uni-kassel.de

For more details of these events and others see the IENICA web site at [www.csf.gov.uk/ienica](http://www.csf.gov.uk/ienica) or contact Sarah Hugo at [s.hugo@csf.gov.uk](mailto:s.hugo@csf.gov.uk)

## Production of Innovative Proteins and Fibres in Pilot-Plant Scale

Innovative markets for plant proteins

Plant proteins are an important source of raw material for both food and non-food uses. The annual production of protein isolates and protein concentrates reaches 1 million metric tonnes worldwide with prices ranging from 1.50 EURO/kg to 5 EURO/kg. Currently, soybeans and wheat proteins represent the most important resource for protein production with some emerging availability of pea proteins and cottonseed proteins.

Although more than 90% of the annual protein production is marketed into the food industry, some non-food applications show growing potential concerning the utilization of plant proteins:

- ~ in paper coating, plant proteins can be used as binder or co-binder in the coating formulation
- ~ in label adhesives, plant proteins can contribute to the cold water resistance of labelled bottles
- ~ cosmetics are a small market by volume but with high value-added potential. Plant proteins are active ingredients contributing to better compatibility
- ~ recent results in R&D indicate that plant proteins can also be used in plastics as the main polymer. Plant protein based plastics show thermoplastic properties and good biodegradation properties.

The suitability of plant proteins in non-food applications is determined by 3 factors:

- 1) Competitiveness: competitive products are EVOH, Polyvinylalcohol and styrole-butadiene-latex or acryl-latex with prices in the range of 2 EURO/kg to 6-7 EURO/kg.
- 2) Availability: protein polymers must be available throughout the whole year in standardized quality
- 3) Product properties: the polymer characteristics requested in non-food applications are different from those in food applications. Chemical modification of plant proteins offers the opportunity to functionalize the polymer properties with regard to specific demands (e.g. molecular weight, molecular weight distribution, charge, structure)

Although competitiveness can be achieved and availability is ensured, plant proteins are currently in most cases purchased as "bulkware" like food products.

The success of increasing the use of plant proteins into non-food applications is mainly determined through the availability of processes for functionalizing proteins by chemical or physico-chemical modification.



Fig.1: General view of the Fraunhofer pilot plant

### Protein functionalizing in pilot-plant scale

Fraunhofer IVV has designed a unique pilot-plant for the concentration, isolation and chemical modification of plant proteins in pilot-plant scale (Fig. 1). Pilot-plant production provides advantages for both producers of protein products and users in food and non-food industry:

- ~ products can be made available in sufficient quantity for preliminary testing in industrial applications. Even pilot production for market testing purposes can be achieved.
- ~ Processes can be evaluated regarding processing yields and energy demand.
- ~ Scaling-up as the basis for an economical evaluation of an industrial production can easily be carried out.
- ~ Pilot-plant processing ensures that processing concepts established in laboratory scale can be transferred into industrial scale.
- ~ Pilot-plant scale investigations contribute to the reduction of costs for developing new processes and products.

The Fraunhofer pilot plant consists of the following modules:

- ~ 4-stage countercurrent extraction unit in continuous operation mode (capacity of max. 50 kg/ha of seeds); this unit is used either for continuous production of functional protein concentrates or continuous extraction processes in protein isolation.
- ~ 2-stage cross-current extraction unit in batch operation mode (capacity of max. 200 kg of seeds per batch); this unit is used for protein isolation processes.
- ~ Universal protein reactor system; this unit is designed to carry out both physical and chemical modification in aqueous or aqueous-alcoholic systems.
- ~ Protein purification unit using acid or heat precipitation and membrane separation.
- ~ Drying; all fractionated products can be dried

(spray drying, mill drying, ring drying) and bagging.

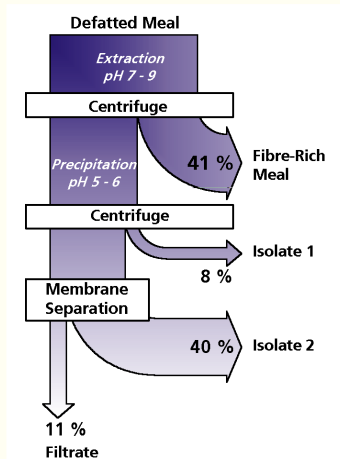


Fig. 2: Mass flow chart indicating yields of protein in the isolation of rapeseed proteins

Fig. 2 shows a mass flow diagram for the production of rapeseed protein isolates. The process has been designed to reach high protein yields and to produce isolates that show high solubility in water. The products have additionally been modified using slightly acid conditions in order to increase the contribution from functional groups of protein side chains to the rheological behaviour of the protein polymer in aqueous systems (eg. adhesives). Fig. 3 shows typical rheological profiles for native and physically treated rapeseed proteins in glue formulations. Compared to commercial casein glues, the results obtained indicate that functionalizing proteins by means of physical or chemical modification is an important step to adapt the product characteristics upon the specific requirements in industrial markets.

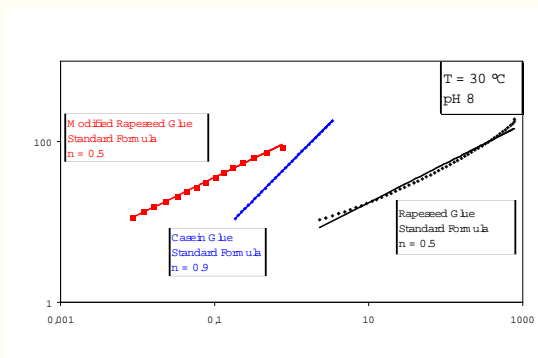


Fig. 3: Rheological profile of glues based upon native and modified rapeseed proteins

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## Biocascading: A New Trend in the use of Industrial Crops

Current state of use of industrial crops

Use of crops and crop products for non-food and non-feed use is an old phenomenon. In particular fibre crops (flax, hemp) and energy crops (trees, especially in the tropics) have been grown for centuries for such purposes. Recently, industrial uses of crops and crop products have gained renewed interest due to the overproduction of agriculture in certain parts of the world, the commonly felt need to use renewable resources and their potential environmental benefits.

Until now research has mainly focused on growing crops for one single type of raw material, to be used in one specific market sector. Examples are: rape seed for bio-diesel, fibre hemp for paper production and crambe for industrial (technological) oils or lubricants. The new crop must then compete with other existing types of raw material, often in markets with low prices and low added values. This is only possible when the benefits of agricultural products are large or when the price:performance ratio of the agricultural products is better. Benefits of the use of agricultural products, however, are not always so obvious. The common argument that they are environmentally friendlier sometimes becomes doubtful when the entire life cycle is analysed. Often institutional barriers or lack of political support impede economic viability. The price:performance ratio is usually lower, due to lower and more variable quality of the agricultural raw material. Moreover, agricultural raw materials are often not flexible in their logistics and use.

New trend: biocascading

This calls for a new approach, which is more flexible, cheaper and makes better use of the raw material. The ideal is a multi-input/multi-output system. Such a system may use different raw materials (either waste, rest products, crop residues or crop products) and produces different types of products through a well-orchestrated chain of sophisticated processes, applying the latest technologies available. An interesting approach to design such a chain of technological processes is integrated plant conversion through biocascading. Integrated plant conversion uses all plant parts to synthesise a variety of products. Cascading means that the initial material is used to produce a high value product and that the waste of this process is further used for a next step in production yielding other products, etc. (multi-output). The final residue may be used for the production of energy. Residues or waste can be added in several phases of the biocascading process to increase the amount of material processed thus increasing the efficiency of the system (multi-input).

Agronomic and technological criteria for selection of potential crops for biocascading may be:

- ~ actual and potential acreage of the crop;
- ~ actual and potential yields of the crop and yield stability;
- ~ main components produced, their actual use and their potential use;
- ~ resource use efficiency of potential crops (especially in relation to use of water, nutrients and crop protectants);
- ~ the possibility to fit the crop in the current production and farming systems (availability of labour, machinery, crop rotation);
- ~ present knowledge on the crop and state of breeding and seed production systems;
- ~ absence of critical problems in the cultivation and use of the crop or its products.

We will illustrate this new development on the basis of two large research projects, which are currently being carried out in the Netherlands, on two different crops, namely grass and hemp.

#### **Example 1: grass**

At the DLO-Research Institute for Agrobiological and Soil Fertility a large research project is being carried out on the bio-refining of grass. The high productivity of grass, the continuous soil cover of the vegetation, and the high resource use efficiency if mown makes this an attractive, high yielding, efficient and environmentally friendly crop. When frequently cut, it produces uniform, vegetative material with high concentrations of:

- ~ fibre for production of paper and composites;
- ~ mono- and disaccharides, oligosaccharides, and polysaccharides for industrial uses, such as the production of alcohol;
- ~ proteins, for animal feed;
- ~ proteins and other chemical constituents for human food;
- ~ and minerals to be included in fertiliser products.

The different fractions are made available by a step-wise bio-refining procedure, which is also environmentally friendly. Manipulation of the composition of the grass through breeding and crop husbandry must assist in optimising the chain.

#### **Example 2: hemp**

In the case of hemp the variety of products through biocascading is potentially even larger. A Dutch consortium is currently initiating research on this crop. Preliminary surveys showed that interesting products for a biocascade approach may include:

- ~ secondary metabolites with high value, such as compounds for medicinal purposes;
- ~ seeds (as bird's feed);
- ~ proteins;
- ~ oils;
- ~ fibres (of different qualities, to produce high-grade paper, low-grade paper, composites, etc.);

- ~ carbohydrates (for fermentation);
- ~ a rest fraction for energy production.

#### **Perspectives**

New concepts require extensive research in which many actors and stakeholders are involved. This is especially true for this development. It requires a new concept in technology, in farming and in multiple purpose land use. Yet, in the long run, the concept will prove to be more viable than the current attempts to grow specific industrial crops for specific non-food/non-feed markets.

**Notes:** The example of grass is based on the Annual Report of 1998 of the DLO-Research Institute for Agrobiological and Soil Fertility (AB-DLO), Wageningen, The Netherlands. More information may be obtained from Dr J.J.M.H. Ketelaars

(e-mail: [j.j.h.m.ketelaars@ab.dlo.nl](mailto:j.j.h.m.ketelaars@ab.dlo.nl)).

The example of hemp is based on the EET project Biocascade, carried out by a Netherlands' consortium of agricultural and technological research organisations co-ordinated by Dr W. van Heugten (Foundation for the Development of Sustainable Chemistry DCO, Wageningen, the Netherlands)

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