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University of Applied Sciences Valais – 'Life Technology'

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Abstract: The competence group 'Life technology' of the HEVs provides education and is actively committed in transfer technology and in applied research & development. The activities of the group are clustered according to three directions: food technology, biotechnology and analytical chemistry. These main domains correspond to the three study programmes for the bachelor degree in engineering. A large range of facilities is available to cover the needs of education and other activities. Technology transfer is made possible thanks to projects in various domains: analytical and food chemistry, development and validation of analytical methods, monitoring and quality control programs and product development. The analytical tasks are performed under strict quality control. The activities of the group are also strongly dedicated to applied research & development. The strategy is structured around the following R & D axes: aromatic and medical herbs, geographic and biological authenticity, assessment of microbiological hazards during food processing, molecular characterization of microorganisms and development of analytical systems.

Keywords: Analytical chemistry · Biotechnology · Food technology · Higher education · Process

1. Introduction

The competence group 'Life technology' of the HEVs combines a higher education and an active commitment to applied research & development (aR&D). The activities of the group are oriented in three main directions:

- Food technology
- Biotechnology
- Analytical chemistry

The group works in close collaboration with other education and research institutions in Switzerland and abroad.

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2. Resources

The human resources at the end of 2001 include 15 professors, 18 scientific collaborators and 15 technical collaborators. Four main laboratories are used for microbiological, genetic (PCR), physicochemical, chemical, and instrumental analyses. They cover an area of about 500 m^2.

Moreover, an area of about 1000 m^2 is used for four pilot plants in the fields of food technology, biotechnology (to be built in 2002), chemical engineering, small-scale and medium scale extraction. Laboratories dedicated for basic teaching represent an area of about 500 m^2.

3. Study Programmes

The basic teaching concept (bachelor degree in engineering) is structured into three study programmes grouped under the general teaching of activities of 'Life technology': food technology, biotechnology, and analytical chemistry. The three tracks contain a common core composed of general education in mathematics, physics, general chemistry, biochemistry, and general microbiology. A programme for postgraduate training is also implemented. Table 1 shows the different courses organised for each programme.

4. Technology Transfer

The HEVs is very active in technology transfer thanks to projects in different domains.

4.1. *Analytical and Food Chemistry*

A large range of techniques is available for varied individual or serial analyses, including hyphenated techniques like high performance liquid chromatography–mass spectrometry (HPLC-MS), gas chromatography-mass spectrometry (GC-MS). Spectrophotometry, light scattering, refraction analysis, fluorescence, conductimetry, and electrochemistry are used for research and development activities as well as for industrial analyses. Examples of applications are analysis of oligomers by light scattering with size exclusion chromatography, sugars by electrochemistry, organic acids by conductimetry.

Separation and identification of organic substances of both industrial and natural origin are also carried out. They may be separated by means of chromatographic methods (GC, HPLC, TLC) and their components may be identified by means of spectroscopic methods such as ^{1}H, ^{13}C NMR, MS, IR, UV-VIS. Examples of applications are the separation and identification of by-products produced during the preparation of a specific compound.

Table 1. Overview of the study programmes

Food technology	Biotechnology
• Process (unit operations) • Quality, security and authenticity of food products (food chemistry, food microbiology, sensorial analysis)	• Bioprocesses (fermentation) • Downstream processing (unit operations) • Bioanalytics (biochemistry, microbiology, food chemistry) • PCR analysis
Analytical chemistry	**Postgraduate training**
• Biological methods • Physical chemical methods • Good laboratory practice • Instrumental analysis methods	• Introduction to chemistry for small and medium businesses • GLP, GMP, HACCP • Polymerase chain reaction • Quality systems according to ISO 9001 • Quality systems and environment • Preparation for certification according to ISO 9001

Qualitative and quantitative analyses of inorganic and organic substances are performed for example to monitor hygiene at the work place. They are also used to detect the presence of low level (ppt) toxic metal residues liberated by used catalysts.

The analytical tasks are performed under strict quality control. The analyses are done with the help of standard operating procedures (SOP) that ensure accurate and reproducible results.

Analyses are executed according to ISO 17025 requirements (Table 2). Several domains of analysis are accredited. The last two domains mentioned: characterisation of active pharmaceutical intermediates and studies of occupational health, will be implemented fully in 2002.

Group of products or materials, field of activity	Principle of measurement (characteristics, measuring ranges, type of test)	Test methods (standards or in-house test methods)
Foods, water, packaging materials	Microbiological and molecular biology analyses: Aerobic and anaerobic plate count, aerobic and anaerobic spores, enterobacteriaceae, *staphylococcus aureus, E. coli*, enterococci, *Pseudomonas aeruginosa*, Salmonella, Lactobacilli and thermophillic streptococci, yeasts and moulds, detection of GMOs	Swiss Food Manual USP 24 European Pharmacopoeia
Beverages	General chemical analyses: density, alcoholic content, extract according to Tabrié, reducing sugars, pH, Brix	Swiss Food Manual
Organic and natural compounds	Structure elucidation: UV-VIS, FT-IR, GC-MS, FT-NMR	Validated in-house test methods
Active pharmaceutical intermediates (API) and similar compounds	Quantitative chemical and physical analyses: HPLC-UV, LC-MS, ICP-OES, FT-NMR, GC-MS	Validated in-house test methods
Occupational health	Analysis of air samples: GC-FID, GC-MS, HPLC-UV, HPLC-fluorescence, HPLC-conductance, UV-VIS, ICP-AES	Validated in-house test methods

Table 2. Domains accredited according to ISO 17025 requirements

4.2. *Development and Validation of Analytical Methods*

Specific methods (HPLC, headspace GC-MS, NMR, IR, ICP, *etc.*) are developed and validated for quantitative and qualitative analyses of active pharmaceutical intermediates (API). The identity and purity of these substances are established. The customers are chemical industries.

Another field of activity is the establishment and validation of specific methods to assess the quality of food products and packaging materials. An example is the assessment of the quality of wine corks with headspace GC-MS. Different parameters have been found to be significant for a potential bad cork taste in the wine. It is of major importance for corks producers, sellers or users (wine producers) to avoid corks able to give bad taste. Regularly corks are sent to the HEVs for analysis to assess their quality.

Development of analytical methods in biological, pharmaceutical, food or environmental materials is also carried out.

4.3. *Monitoring and Quality Control Programmes*

These programmes are performed within the framework of microbiological analysis and hygiene control and risk assessment of process lines – implementation and assessment of HACCP (hazard analysis critical control point) plans.

The monitoring and hygiene control of processing lines are executed in different factories with the aim of verifying and improving the procedures of good hygiene. Assessment of microbiological risks is made throughout the primary production, processing, storage, and distribution of food. HACCP plans of food production and handling facilities are developed, implemented and audited.

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4.4. *Product Development*

An important part of the group activities is to develop new products. An example is the beverage 'Bio Alp Tea' now commercialised at a national level. Technical and commercial skills were required to carry out this project from the idea to promote the use of plant extracts to the commercialisation of a final product. Other products now commercialised were also developed: the alcoholic drink 'Abricool', a mix of aromatic herbs with a *bio* label, marinades for meat and fish, *etc.*

5. Applied Research Axes

5.1. *Aromatic and Medical Herbs*

A first axis of the group deals with aromatic and medical herbs used for food or pharmaceutical purposes (Fig. 1). This activity includes:

- Extraction and purification processes,
- Extraction and quantification of essential oils,
- Analytical characterization of active substances.

A continuous process for the extraction of active substances from plants has been patented.

In order to promote agriculture in mountainous areas, a project has been implemented to develop products made with typical plants of those areas, in particular with alpine wormwood (*genépi blanc*). A beer flavoured with alpine wormwood was developed up to the pilot level. Other food products containing alpine wormwood extracts are now in early phases of development.

5.2. *Geographic and Biological Authenticity*

The *geographic authenticity* of food products can be best determined by isotopic means, such as IRMS (isotope ratio mass spectrometry) and NMR (nuclear magnetic resonance). Projects were carried out with the Swiss Federal Office of Public Health (SFOPH) in order to determine the authenticity of Swiss wine and Emmental cheeses. For the wine, 75 samples of grapes were collected in the most relevant wine-growing areas of Switzerland. Musts of grape were produced and subjected to two stable-isotope analyses following the relevant EU methods. The results show that a combination of the ^{2}H-NMR and ^{18}O/^{16}O-IRMS data and linear discriminant analysis allows a separation of Swiss wines in four main regions: Valais, Tessin, eastern (German-speaking), and western Switzerland (Romandie) (Fig. 2). This project will continue for one more year, including also commercial wines and measurements of selected metals and minerals as well as further analytical parameters by inductive coupled plasma optical emission spectrometry (ICP-OES).

For the evaluation of the *biological authenticity* of food products, the polymerase chain reaction (PCR) is a very powerful technique. This method is highly specific and enables the detection of even small amounts of nucleic acids (DNA, RNA). Qualitative as well as quantitative real-time PCR is used for the detection of specific food compounds, as for example GMO detection, determination of animal species or checking foodstuffs for the presence of allergens.

5.3. *Microbiological Hazards During Food Processing*

Assessment of microbiological hazards during food processing (HACCP) composes another axis of applied research activities. A research project over two years concerned the evaluation of risks during production and storage of food. The primary production was included. The foodstuffs studied were aromatic plants, sprouted seeds, liquid eggs, fresh and dry pastas. The principal results were the characterization of the process parameters in order to ensure the microbiological safety of those foodstuffs; new criteria were proposed to evaluate the quality of certain foodstuffs. Different types of parameters were assessed: study of the microbiological flora during the growth of plants and seeds, tests on parameters of pasteurisation for the liquid eggs and fresh pastas, and assessment of the drying parameters for dry pastas. For most of the products, one aim was to lower the amount of the initial flora, in particular the pathogenic microbes and/or to prevent them from growing. Furthermore, the results could help in the elaboration of a manual for good processing practices.

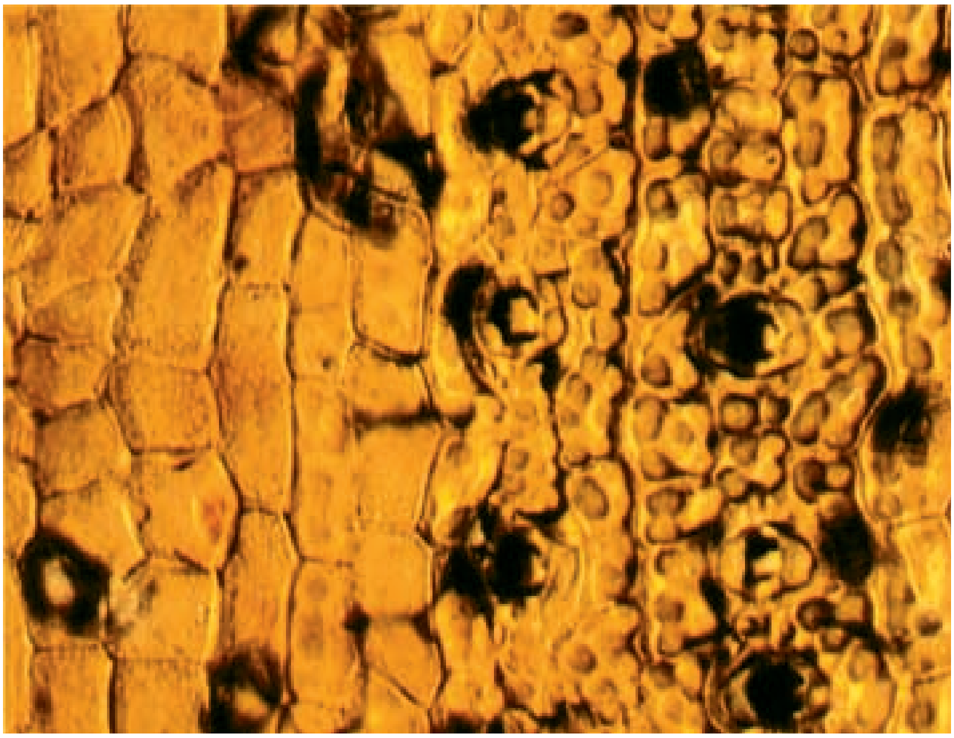

Fig. 1. Microscopic view of an aromatic herb containing essential oils

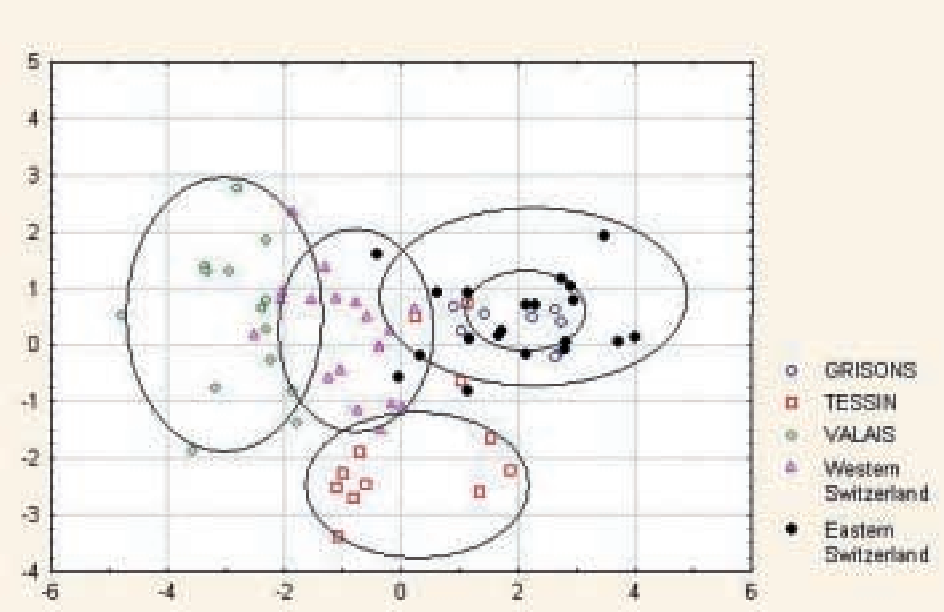

Fig. 2. Discriminant analysis by NMR and IRMS of Swiss wines

5.4. *Molecular Characterization of Microorganisms*

The traditional methods for identifying or typing microorganisms include various culture techniques, biochemical tests and morphological examination. These techniques are labour-intensive and time-consuming. In addition, they are not very discriminating for typing on the strain level and sometimes they cannot distinguish the microorganisms at the species level.

In contrast, genetic analysis allows rapid and specific identification and characterization of microorganisms at the species as well as at the strain level.

During the last few years, skills and knowledge have been built up in the application and the development of methods based on qualitative and quantitative real time PCR, hybridisation techniques, pulsed field gel electrophoresis (PFGE) or restriction fragment length polymorphism (RFLP). Collaboration takes place with industrial partners, private and official control laboratories as well as academic institutions in Switzerland and abroad.

In one of the current projects, methods are developed for the quantification of microorganisms (yeast, bacteria) during wine production. Methods are to be developed that make it possible to distinguish between viable and dead cells. The final aim is to help the wineries to have better control over fermentations.

5.5. *Development of Analytical Systems*

Systems are developed to control parameters on production lines and on final products such as packaging material.

An example is the development of an analytical apparatus ('TV 9000') for the determination of global volatile substances, made in a joint development collaboration between the HEVs and Brechbühler AG. In this concept, the sample volatiles are extracted onto a solid phase micro extraction (SPME) fibre then desorbed into a gas chromatographic detector (FID, PID, NPD, *etc.*) without the classical gas chromatographic separation of the components. The resulting signal is a single peak whose area is proportional to the global quantity of volatiles in the sample. It allows for the global determination of volatiles present in the sample headspace by a rapid technique comparable to an electronic nose. An advantage of the technique proposed here is that, if it becomes necessary to make further qualitative and quantitative investigations, the same concentration process can be applied for a chromatographic separation.

The HEVs has developed methods for the rapid global quantitative determination of volatile compounds for various applications: freshness of fish, quality of bitter almonds, solvents in water, olfactive neutrality of papers, solvent elimination from chemicals, aroma intensity of beverages, maturity of cheese, milk quality, essential oil content in aromatic plants. The Swiss Commission for Technology and Innovation has funded part of this project.

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