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Institute of Food Science and Nutrition ETH Zürich

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Abstract: The Institute of Food Science and Nutrition consists of five laboratories: the Laboratory of Food Chemistry and Food Technology, the Laboratory of Food Process Engineering, the Laboratory of Food Microbiology, the Laboratory of Food Biotechnology, and the Laboratory of Human Nutrition. Six professors co-ordinate the teaching programme for the undergraduate course in Food Science and each has his own focussed research programme. In addition the Laboratory of Human Nutrition co-ordinates a one-year postgraduate diploma in Human Nutrition. The following review describes the teaching and research programmes, and selected projects.

Keywords: ETH · Institute of Food Science and Nutrition · Research · Teaching

1. Teaching Concept

1.1. *Diploma Course for Food Scientists*

The ETH food science degree is designed to train food scientists in a way that meets the needs of the modern food industry. The ETH food scientist receives an interdisciplinary training with an international orientation which is built onto a sound foundation in the basic sciences. This permits the students to acquire a substantial knowledge of all sciences and technologies related to food, its transformation, its influence on health and disease, as well as an understanding of the economics essential to the food industry. The course lasts nine semesters which includes four semesters of basic science, four semesters of food specialisation and a diploma thesis of four or five months. The basic science course is broad and includes mathematics, physics, chemistry, biology, informatics, food chemistry, food processing, food technology, biochemistry, immunology, anatomy, and physiology. The specialised teaching areas are food microbiology, food chemistry, food technology, food biotechnology, food engineering, human nutrition, and economics.

1.2. *Postgraduate Course in Human Nutrition*

The graduate of the Postgraduate Course in Human Nutrition at the ETHZ has had over 600 h of study with a broad exposure to the field of human nutrition, including aspects of nutritional epidemiology, physiology, food science, but with a focus on the interactions between diet and health. The student is instructed through lectures, seminars and demonstrations. In addition, each student completes a Studienarbeit (140 h), allowing them to focus in greater depth on a specific nutritional topic. Each student enters the course from a profession (the most common being pharmacy, food science, or biology) and is encouraged to 'tailor' the course to his or her own individual interests. The NDS is meant to provide nutrition expertise which is incorporated into and used together with the student's previous training and profession. The NDS graduate is thus, for example, a food scientist with a specialisation in nutritional impact of foods, a food chemist with a specialisation in the food nutrient content, or a pharmacist or physician with an in-depth knowledge of nutrition and diet and its role in health promotion.

1.3. *PhD Programmes*

The doctoral thesis is the most important postgraduate qualification at ETHZ and each laboratory within the institute offers PhD programmes related to their specific research areas.

2. Research Areas

2.1. *Food Chemistry*

The activities of the Food Chemistry Group concentrate on three main research topics.

• **Food Chemistry and Quality:** Plant cell wall polysaccharides are, among others, responsible for the texture of fruit and vegetable products. The amount and nature of pectic substances present in fruits and vegetables during growth, ripening and storage strongly influences this functional property. The pectic substances of apples of different degrees of ripening are stepwise isolated by chemical and enzymatic treatment, and characterised in detail by determining their monomeric composition, types of glyco-

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sidic linkages, and branching patterns. The main purpose of this work is to elucidate the influence of the chemical structure of pectic substances on the changes of the textural properties of fruit and vegetables during ripening and storage.

• **Food Chemistry and Health:** Dietary fibre is known to beneficially affect human health. Processing may alter the chemical structure and the physicochemical properties of dietary fibre and thus the nutritional properties of food rich in dietary fibre. Therefore, establishing these changes helps to understand the metabolic fate of processed food in the gastrointestinal tract. *In vitro* methods mimicking digestion in the small intestine and fermentation in the colon are used to evaluate the physiological effects. In addition, model experiments are carried out with indigestible carbohydrates to establish the potential of dietary fibre, *e.g.* as prebiotics or ingredients in functional food.

• **Food Chemistry and Flavour Compounds:** The influence of light and oxygen (photo oxidation) on the odour compounds formed during the degradation of furan fatty acids which are present as minor constituents of the lipid fraction in dried herbs (*e.g.* green tea, chives, basil, dill) is investigated to obtain information on the effects of light-induced oxidative degradation products of furan fatty acids on the sensory quality of food.

2.2. *Food Technology and Sensory Science*

Food technology involves production, transformation, preservation as well as storage and distribution of foods. It deals with food from raw material through all steps of processing to the product ready for consumption. In all these steps activities of food technology are focused on the intrinsic product quality which in turn is determined by physiological factors (nutritional value, wholesomeness, 'health value') and psycho-biological or sensory factors (colour, flavour, texture). The main research areas of the group comprise the optimisation of food quality during thermal processing of foods (heat sterilisation, dehydration, roasting, baking, frying, extrusion cooking), relationship between physical properties, micro- and macro-structure and quality of plant food material (cereals, potato, yam, coffee, apple), starch transformation and its interactions in multiphase colloidal food systems (flavour retention and release), and psycho-physics and analytical sensory evaluation of foods by static and dynamic methods (flavour interactions in hard boiled candies, texture of table apples). Accordingly, small-scale pilot plant installations, microscopy, thermal analysis, rheometry, sensory methods, and selected chemical analyses are among the 'experimental tools' used in the various research projects.

2.3. *Food Process Engineering*

Research in the Food Process Engineering Lab couples two main research fields which are: Process Engineering and Biomaterial Sciences.

In Process Engineering the main focus is on flow processes and their impact on microstructuring of biological material based on the application of momentum, heat, and mass transfer.

In the Biomaterial Science field the lab works on the physical characterization of related systems, in particular developing and applying methodologies in rheology and microstructure analysis. Exemplary processes investigated presently are mixing and dispersing, extrusion, continuous crystallization, spraying, spinning, and solid-liquid separation. The rheological research relates to development of new techniques/apparatus for in-line rheometry and the characterization of complex multiphase systems in uni- and multi-axial shear and elongation flows. Typical systems in focus for microstructure investigation are suspension, emulsion, and foam multiphase structures as well as biopolymer networks and interfacial layers. These research topics relate to applied food product systems like ice cream, confectionery, mousse products, bakery, mayonnaise/salad dressings/sauces, and milk products.

2.4. *Food Microbiology*

Research in the Laboratory of Food Microbiology concerns the following topics:

• **Biochemistry and genetics of propionibacteria and bifidobacteria:** These bacteria are used as starter cultures in cheese production and as probiotic additives. The interest centres on the mechanisms of oxygen resistance, the formation of bacteriocins, and the characterisation the typical phosphoketolases of bifidobacteria. Vectors for genetic transformation are being and have been developed to aid studies on structure and functions of genes of interest.

• ***Clostridium perfringens:*** This strictly anaerobic food-borne pathogen can thrive in food even in the presence of moderate concentrations of oxygen. One compound involved is the recently discovered rubrerythrin which has some superoxide scavenging activities.

• **Antibiotic resistant bacteria in food**: Such bacteria contaminate food of animal origin during slaughtering and milking. If no heating step is involved, some bacteria like enterococci may even multiply to high numbers in food. If they reach the consumer they may transfer their resistance genes to bacteria of the human intestinal microflora. The laboratory has characterised on a molecular level the mobile genetic elements (plasmids and transposons) involved in a potential transfer. Genes already known from pathogenic bacteria have been detected. The methods for the elimination of resistant bacteria are being developed.

• **Protective cultures:** Some starter culture components (lactobacilli, propionibacteria) are able to inhibit the growth of yeasts and fungi. Proper cultures are presently optimised to protect commercial yoghurt preparations. In addition, cheese surface cultures (coryneform bacteria, staphylococci, certain yeasts) are developed for a better and reproducible function.

• **Food safety:** Nucleotide probes are evaluated to detect resistance and toxin genes directly in food by real time PCR.

2.5. *Food Biotechnology*

The Laboratory of Dairy Science has been replaced by a Laboratory of Food Biotechnology. The new food biotechnology programme will be introduced from August 2002 by Christophe Lacroix.

2.6. *Human Nutrition*

The research focus of the Human Nutrition Group is diet and health. Dietary factors influencing mineral and trace element absorption are evaluated in human subjects using stable isotope techniques and mineral and trace element status is monitored using various methodologies. In industrialised countries, our focus is bone health, magnesium and diabetes and iron nutrition during pregnancy. Osteoporosis, leading to bone fractures is a major concern during ageing and our studies evaluate dietary factors (calcium, phytoestrogens, salt, protein) that influence age-related bone loss. Potentially useful ingredients for functional foods are considered. In developing countries, research is focussed on food-based strategies to combat deficiencies in iron, iodine and vitamin A. This is mainly food fortification but also included genetic engineering and plant breeding (biofortification). Iron and iodine fortification are the main focus. Studies related to type of compound, factors influencing iron absorption, and interventions with fortified foods to demonstrate an improved status in populations. Current programmes include fortification of salt with iron and iodine in Morocco and Ivory Coast, iron fortification of fish sauce in Vietnam and Thailand, and weaning food fortification in Bangladesh.

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