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Higher Education in Food Chemistry[1]

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Introduction

Information on higher education in food chemistry in Europe has to start by defining the field and the tasks of this discipline.

Food chemistry is an important part of what is often described as «food science» and which is also called «bromatology» in some countries. As broma is Greek for «food», this term can be considered equivalent to «food science». Food science also comprises food physics, food microbiology, food hygiene, knowledge and history of commodities, et cetera. Food technology, as a rule, is mentioned separately; the usual term is thus «food science and technology». Nutrition science is in many ways related to food science but does not belong to this discipline.

Many areas are of particular importance in the field of food science (1); these can be enumerated as follows:

1. The study of the properties of both raw and prepared foodstuffs;
2. The study of the composition of foodstuffs and the properties on their individual components;
3. The study of changes in composition and properties during manufacturing, preparation and storage; the development of methods for measuring these changes and of procedures to delay or to prevent unwanted changes;
4. The assessment of quality, wholesomeness and safety of foodstuffs (this also comprises the content of nutrients and the organoleptic properties);
5. The recognition of harmful organisms and components in foodstuffs and, where possible, the development of methods to prevent or eliminate these;
6. The development of methods of analysis for establishing the composition of foodstuffs and for the determination of harmful or otherwise undesirable components in foodstuffs;
7. The development, in cooperation with jurists and others, of adequate food laws, designed to protect public health and to promote fairness in trade.

[1] This article is an extended revision of a lecture held at the 2nd EFFoST conference «Education, training and qualification of food scientists, engineers and technologists for industry and trade in the 21st century», Brussels, April 1991. Original publication in Microbiologie, Aliments, Nutrition **10**, 83–97 (1992)

It will be clear that chemistry is a very important tool for all these areas, particularly for the items indicated by the numbers 2, 3 and 6. For this reason, any curriculum for food scientists and technologists should embrace an education in chemistry. It must be emphasized that, on the other hand, curricula in food chemistry should contain courses in other fields having relevance to food science and technology.

It has to be stressed that experts in food chemistry are indispensable for an effective regulatory control. This is particularly true for the European Common Market where control of food has to be effected in the countries of origin, and this at the same level of quality throughout Europe. Experts in food chemistry are also required in food industry which has to guarantee the quality of its products, and these experts, as a matter of fact, should have the same level of food chemistry training as their partners in regulatory control (2).

Curricula including food chemistry

There are several possibilities for higher education in food chemistry in Europe.

First, there are complete university programmes for training as a food chemist. This is particularly the case in Germany, where the education is settled by legislation. Complete curricula in food chemistry are taught today at sixteen German universities, resulting in the official certificate of «Lebensmittelchemiker» (Food Chemist). Food inspection in Germany has been in the hands of such «official» food chemists since 1894. They are also working for quality assurance in food industry or as public analysts.

In this context the British «Public Analyst» should be mentioned as well, although his competence includes more than just food (3).

Second, there are many curricula in food technology, which include a more or less thorough training in food chemistry. As food technology can be defined as «the application of scientific methods to develop or improve procedures for the manufacturing of foodstuffs of desired quality, and of techniques to establish and to maintain this quality» (4), it is obvious that these curricula also need to include some education in food chemistry.

Third, there are programmes in food chemistry in curricula of the agricultural sciences.

Fourth, there are curricula in chemistry and pharmacy in which a choice can be made for a course in food chemistry. This enables chemists to have a better start if they are subsequently engaged in chemical research, or other chemical work, in the areas of food or foodstuffs. A comparable argument holds for pharmacists; moreover, it should be bourne in mind that an important part of their education is analytical chemistry.

In some cases food chemistry is incorporated in a course which includes both biochemistry and food chemistry.

Finally, most veterinary educations allow the students to get acquainted with problems of chemical food hygiene. This may sometimes include a short course in food chemistry and/or in chemical analysis of foods of animal origin.

Food curricula in Europe

It was at one of the meetings of the Working Party on Food Chemistry[1] in Vienna that food curricula in Europe were discussed, and the question arose which universities in Europe had curricula in food chemistry, and how these curricula were built up.

A survey of food science and technology education in Europe was undertaken earlier by the Commission of the European Communities, and launched at an international symposium in 1979, also in Brussels (5). This survey was focussed on training in relation to food and associated industries in the EC, and contained a lot of detailed information.

A need was still felt, however, to compile curricula in food chemistry and to describe the present-day situation. As could be expected, it was not so simple to obtain a more or less complete overview of the European situation. One of the tasks is collecting data on these curricula, trying to gain an insight into the situation, thereby to gradually complete the information. Of rather more importance are the answers to the questions of which type of knowledge of food chemistry is required by industry, by trade, by governments and – in general – by all institutions performing any work with respect to food or foodstuffs, and the extent of that knowledge of the situation and the background before systematic answers can be provided.

At first, a description of the different situations in those European countries on which information was available will be presented. The sequence is rather arbitrary.

Germany (2): The complete curricula in food chemistry have been mentioned already. A two years basic programme is in general identical with the overall basic programme in chemistry but this also includes botany. The main programme (again two years, under the responsibility of special University institutes of food chemistry) has the emphasis on chemistry and the analysis and technology of food, drinking-water, cosmetics and articles of use. These are covered by means of lectures and extensive practical work. Additional subjects are food microbiology, food legislation, chemical toxicology, nutrition, etc. The study is completed by a

[1] The Working Party on Food Chemistry (WPFC) is one of the working parties belonging to the Federation of European Chemical Societies (FECS). At the moment, most European countries have delegates in this Working Party, which meets every year in September. An important activity of the WPFC, which was founded in 1977, is the organisation of international symposia on food chemistry. These include the Euro Food Chem conferences and, mostly in cooperation with other working parties or societies, other conferences, which sometimes have an interdisciplinary character.

practical year which has to be spent in an official laboratory for food chemistry, and by two state examinations. A scientific investigation is scheduled to be introduced. Yearly more than 200 students are educated.

There are no post-doctoral courses for food chemists or partial trainings in food chemistry. One university contains an institute in which teachers involved in professional training courses are taught food chemistry.

Food technology curricula exist at two universities (Karlsruhe, Hohenheim) and at two technical universities (Berlin, München). Such curricula are completely separated from those in food chemistry but, as a matter of fact, these include some food chemistry.

In the former GDR the curricula in food chemistry were comparable, but without the practical year. These existed only at two universities, i.e., the Humboldt University at Berlin and the Technical University of Dresden. The numbers of students were not very large. Food technology was taught at four universities.

Students at faculties of veterinary medicine are taught some basic and some practical knowledge which enables them to judge unprocessed food of animal origin. These programmes include food hygiene but not food chemistry.

In *Switzerland* (6), the five years curriculum of the Eidgenössische Technische Hochschule in Zürich (ETH, Swiss Federal Institute of Technology) fulfils an integral part in the education of food scientists. The total annual instream is about 120 students.

Under a special ordinance (first version in 1919) Switzerland has defined the position of Official Food Chemist, which to a certain extent is comparable to the Official Food Chemist in Germany.

The Federal Diploma of Food Chemist, which may lead to a position as official food chemist, is issued on the basis of an examination. The condition one has to fulfil in order to qualify for the examination itself is one of the following:

- a Ph.D. degree, a diploma in chemistry or a diploma in food engineering from a Swiss university;
- a Federal pharmacist's diploma;
- a diploma in agricultural and food sciences from the ETH and a pass certificate in physics, botany and hydrogeology, if these subjects have not been included in that diploma.

Furthermore a candidate should have attended some courses and lectures on special subjects. In addition to that, he or she should have worked for a period of at least two years in one of the official food analytical laboratories in Switzerland. It is worth mentioning that attending the above-mentioned courses and lectures is usually allowed during the practical stage of attendance at one of the food analytical laboratories. The final examination comprises theoretical examinations on the main subjects, i.e., food technology, food analysis, toxicological analysis, bacteriology, hygiene and knowledge of the legal requirements concerning food. In addition to this, there is also a practical examination in an official food laboratory (preferably the one where the candidate is already working).

Four Swiss universities (Basle, Berne, Geneva, Lausanne) teach food chemistry to students in chemistry and related disciplines which can become a part of the diploma.

It should be noted that this overall situation is considered by many persons to be unsatisfactory due to its complexity and length. The suggestion has been made to create a curriculum in food chemistry at the ETH which would directly lead to the Federal Diploma.

The Faculty of Veterinary Medicine at the University of Berne has a course in meat analysis and hygiene of food of animal origin, whilst the course at the Faculty of Veterinary Medicine in Zürich contains hygiene only. Both courses are part of the diploma in veterinary medicine.

The only full curriculum in Food Chemistry in *Austria* (7) is offered by the General University of Vienna. During the first half of this study (2.5 years) analytical, inorganic, organic, biological and physical chemistry are taught. The second half comprises food chemistry, food technology, botany, microbiology, nutrition and toxicology.

At the Technical University of Vienna five-year curricula in Technical Chemistry exist, in which four branches can be distinguished, i.e., inorganic chemistry, organic chemistry, chemical engineering, biochemistry and food chemistry. The first part (2.5 years) is a joint programme in which basic science and some technical topics are taught. For the branch Biochemistry and Food Chemistry, the programme of the next 1.5 years contains basic chemistry, microbiology, chemistry and technology of natural substances, food chemistry and biotechnology. One semester is for exercises and attending lectures at choice; the last semester consists of performing an investigation or part of an investigation («Diplom-Arbeit»).

The branch Biochemistry and Food Chemistry is also taught at the Erzherzog Johann (Technical) University at Graz, where it can be followed after a 2.5 years' course in chemistry.

In addition, the Agricultural University in Vienna is offering a five-year curriculum in food technology and biotechnology. This includes one-year lectures and one-year laboratory exercises in general chemistry and in food chemistry. During the study the students have to work for six months in food or biotechnological industries or in government food control laboratories, usually during the summer holidays. The curriculum is completed by performing an investigation (Diplom-Arbeit). Both at the Technical and at the Agricultural University the degree of Diploma Engineer can be obtained.

The faculty of Veterinary Medicine at this university, according to statute law, has a post-graduate course in Food Hygiene.

In *Czechoslovakia* (8), food chemistry as well as food technology can be studied at the Faculty of Food and Biochemical Technology of the Prague Institute of Chemical Technology and at the Chemical Faculty of the Polytechnical University at Bratislava.

Five years of study is necessary to obtain the degree of Chemical Engineer. During the first 2.5 years general chemistry, biology and engineering are taught.

The second (equal) period is devoted to food science in general and to one of the following specializations:

- food chemistry and analysis
- enzymic engineering
- fermentation chemistry and bioengineering
- sugar chemistry and technology
- food preservation and meat technology
- milk and fat technology.

Food hygiene can be studied at the Veterinary Schools in Brno and in Kosice. A course in food chemistry is obligatory for students who chose for the specialism of food hygiene, but is also open for other students of veterinary medicine.

Post-graduate studies in food chemistry are held at the Institute of Chemical Technology in Prague, and at the Faculty of Chemistry in the Slovak Polytechnical University in Bratislava. The goal of these post-doctoral studies is to deliver graduates able to improve qualification and regulation with respect to food.

Hungary (9) has full curricula in Food Technology at the Technical University of Budapest, the University of Horticulture and Food Industry, also in Budapest, and the College of Food Industry in Szeged. At the Universities three years' curricula (engineering degree) and five years' curricula (diploma engineer degree) are organized. In Szeged only the three years' curriculum exist. The engineering degree is more practical, whilst the diploma degree is more theoretical and less specialized. Food chemistry is generally one of the topics and includes lectures, laboratory practice and industrial practice.

Courses in food chemistry are taught at some faculties of chemistry (Debrecen, Gödölló), but no special chairs in food chemistry exist. A course in food science is obligatory for some groups in Animal Science and for Veterinary Medicine as far as it concerns students engaged in veterinary food control.

Post-graduate trainings in food chemistry are given in Budapest and at the Agricultural University in Keszthely. There are short courses (1 to 3 months) and special courses (1 to 2 years) leading to a certificate.

Food science can be studied in *Poland* at the two technical universities (Gdansk, Lódz) and at the seven agricultural universities (Warsaw, Olsztyn, Poznan, Kraków, Wroclaw, Lublin and Szczecin) (10). All these universities educate to only one type of degree, which takes five years, but a programme dividing the courses in two steps is under discussion now.

The curricula vary from university to university. Generally there is no special course in food chemistry. Only at Gdansk and at Kraków courses in food chemistry are obligatory. No university in Poland has a chair in food chemistry.

At some Medical Universities students can choose for bromatology within the faculty of Pharmacy. This includes some elements of food chemistry as well as methods for the analysis of food.

Up till now there are no post-graduate courses in food chemistry.

In *Bulgaria* food science is taught at the Higher Institute of Food and Flavour Industry at Plovdiv. The programme covers five years.

There is no speciality of food chemistry in Bulgaria yet. However, such a speciality is being organized now in Plovdiv, and a specialization after the third year will be started at the Faculty of Chemistry of the Kliment Okhridski University at Sofia.

A post-graduate training in food chemistry and biochemistry exists at the Plovdiv institute and will be organized, in the near future, in Sofia as well (11).

Further information regarding education in food chemistry in Eastern and South-Eastern Europe is scarce. A curriculum in food technology in Zagreb (Croatia) contains some food chemistry but not in a specialized course (12). Other information from this area was not available at the moment.

In the *United Kingdom* there are about forty first-degree courses in Food Science and/or Technology at universities and at institutes belonging to the Council for National Academic Awards (CNAA) (13). These lead, in three or four years, to a B.Sc. degree. One can distinguish between a «pass» degree (usually three years) and an «honours» degree (usually four years). There is not one uniform course but a variety of programmes differing from one university (or institute) to the other. Courses with the title «Food Science» (about one-third of the total number) are aimed at providing a balanced coverage of the discipline and involve a smaller contribution from technological aspects, allowing greater emphasis on fundamental scientific issues.

As for a U.K. food science education, the course in Food Science at the University of Leeds may serve as an example. It is one of the last that has a four-year curriculum.

The first year's programme includes lectures and practical work on physics, organic chemistry, biophysics, biochemistry, food biochemistry and food technology. Furthermore, lectures on mathematics are given.

In the second year, physical chemistry and general microbiology are introduced. Food science is extented to food quality and nutrition, food physics and food engineering, food colloids, texture and rheology, and legislation, statistics and computing.

Food microbiology is taught in the third year in connection with the general microbiology course given previously. During this year, food science includes chemistry and biochemistry of the major food components, principles of food processing operations, interactions of food components, and food analysis.

The last year is devoted to processing and storage of the major food commodities and to multiple options on various advanced topics. Finally, a research project and a team project should be carried out.

In addition to a B.Sc. education degree, M.Sc. courses in Food Science can be followed, even when the B.Sc. degree obtained is not in this field. (A relation with food science, however, is desirable.)

M.Sc. courses with respect to food science, as a rule, are rather specialized and are in many cases devoted to some particular commodities. Several food chemistry courses exist. An M.Sc. course usually takes 18 months. As the interest for M.Sc. courses is large, it is not always easy to obtain a place in such a course.

Apart from this all, the training that leads to the Mastership of Chemical Analysis (M. Chem. A.), necessary for being appointed as a Public Analyst, has to be mentioned here. The candidate should have adequate experience in a Public Analyst's laboratory or in closely related work. The examination consists of three parts (i.e., A, B and C), which include theoretical and practical parts (3).

No food science is present in the curricula of faculties of Veterinary Medicine (14).

In *Ireland* (15), food chemistry is available as a subject only at University College, Cork. Recently (1990) University College, Dublin, introduced general food science as an option within their Agricultural Science programme. The Veterinary Faculty of this university also includes some aspects of food science in their programme.

One course in Cork leads to a single subject honours B.Sc. in food chemistry. In the first year, chemistry, physics, mathematics and biology are taught. In the second and third years, food chemistry is the main theme with biochemistry also obligatory. In the third year, students may choose one of the following: chemistry, microbiology or nutrition, as their subsidary subject. The fourth year is devoted to food chemistry only.

Food chemistry is taught as the main subject in a pass B.Sc. programme. The first two years are as for the honours programme; the third year contains food chemistry plus two of the following: biochemistry, microbiology, nutrition, chemistry or mathematics.

Finally, food chemistry is a part of a four years course in Food Science and Technology, but the total time devoted to food chemistry may exceed that of the pass B.Sc. programme.

In *France* (16), food science is considered to be a specialized field that can be studied after a general education only. This general education takes a period of 4 years at a university or by means of the particular French system of «Grandes Ecoles». The specialized training in food science consists of a one-year course. There are several food science courses in France, mostly taught by a Grande Ecole associated with a university. The relative importance of the food chemistry part varies from course to course.

Another option leads to an M.Sc. degree in which training in food chemistry is often more prominent. The participation in these degree courses is limited because of selection criteria. The courses can be followed at four institutes in Paris, i.e.:

- INA P-G (Institut National Agronomique Paris-Grignon), which has a very marked orientation for food chemistry);
- ISAA (Institut Supérieur de l'Agro-Alimentaire);
- ENGREF (Ecole Nationale du Génie Rural, des Eaux et Forêts),
- ENSV (Ecole Nationale des Services Vétérinaires).

As in the United Kingdom, no courses in food science exist at faculties of Vcterinary Medicine (14).

Finally it has to be mentioned that courses in food analysis can be followed in some of the French faculties of Pharmacy.

Four universities in *Italy* (17), i.e., in Milan, Udine, Naples and Campobasso, have full curricula in Food Science and Technology (five years). These curricula contain many elements of food chemistry such as chemical analysis of food, biochemistry of food, additives and residues in food, fermentation chemistry and flavour chemistry, but do not have a special course in food chemistry.

Chairs in Food Chemistry are attached to the faculty of Pharmacy at twelve universities. In Milan, such a chair is attached to the Faculty of Agriculture. The courses (on a semester base from 1991 on) vary from university to university but in most cases cover a systematic description of food products. The course is obligatory for the curricula in Pharmaceutical Chemistry and Technology and facultative for the curricula in Chemistry and in Pharmacy. It is also offered to students in biology and to students in other faculties (though rarely attended by this category).

Post-graduate training in food chemistry and technology is offered at the universities of Parma and Bologna. The purpose of these two-year courses is to provide professional qualifications for advanced food technologists to be employed in the food industry.

The faculties of Agriculture at the universities of Milan, Udine and Bologna have three-year post-graduate courses in food biotechnology leading to a Ph.D. degree, whilst the faculty of Medicine in Rome offers a three-years course in food science which is directed towards nutrition.

In one of the faculties of Veterinary Medicine (Perugia), an optional course in chemical analysis of food of animal origin exists.

Spain (18): Until now, there are no complete curricula for Food Science and Technology. For students who graduated in chemistry, biology, pharmacy, veterinary medicine or at a polytechnical university, a course in food technology can be followed which, after ten months, leads to a diploma. Since 1985, post-graduates can receive a M.Sc. degree in Food Technology and Engineering in Valencia.

Recently, courses in food technology were introduced in some Spanish faculties of chemistry. Food chemistry is now included.

As in Italy, several chairs in Food Chemistry exist at faculties of Pharmacy (19).

In all faculties of veterinary medicine, science and technology of food of animal origin is taught. Murcia has a course in bromatology, and Barcelona offers an optional course on chemical analysis of food of animal origin (14).

The situation in *Portugal* with respect to food chemistry is a more or less complicated one (20). Food analysis is taught at the faculties of Pharmacy in Coimbra, Lisbon and Oporto. The courses include chemical and microbiological aspects of food, but no attention is paid to other aspects of food science.

Full curricula in food science and technology exist at Braga, Coimbra and Oporto. The Technical University of Lisbon and the Catholic University of Oporto have post-graduate courses in food science and technology with full curricula. At the Universidade Técnica Superior de Agronomia, Lisbon, food science and technology are included in some curricula, in varying quantities. Courses including food chemistry are available as well at the Escola Superior de Medicina Veterinária

and the Instituto Superior Técnico, both at Lisbon. Food chemistry is also included in a course on biochemistry at the University of Aveiro.

In *The Netherlands,* food chemistry can be studied at the Agricultural University in Wageningen. The undergraduate state lasts at least four years and leads to a M.Sc. in food engineering. The second stage may be research training culminating in a Ph.D. (again four years).

In the first year, the students take courses in basic disciplines such as physics, general and physical chemistry, mathematics and statistics, cell biology, economics and an introductory course in food and nutrition. After this, they have to choose for one of the four major programmes, i.e., food science, food process engineering, dairy science and a free orientation. In all programmes the students have to take a series of basic courses in food technology (introduction to process engineering, food process engineering, introduction to food chemistry, introduction to food physics, introduction to food microbiology and hygiene, human nutrition, food toxicology) and a differentiation programme (in total two years of study). As to food science there are five differentiations, i.e., food chemistry, food microbiology, food physics, quality assurance and food fermentation. Basic courses and differentiation take another two years. The last year includes advanced courses in food technology subjects plus some other courses, a training period in industry and a research project of five months.

At the University of Utrecht a chair in food chemistry is attached to the Faculty of Veterinary Medicine. The contribution to the veterinary education is in the field of meat chemistry and of chemical food hygiene (contaminants and veterinary drug residues in food of animal origin). Since a few years, food chemistry is taught, also from this chair, within the faculty of Pharmacy. Students of various disciplines can take a five months research training in food chemistry.

In *Belgium* (19), no food chemistry is incorporated in any chemical curriculum except in Antwerp, where food chemistry is one of the options.

All students in Pharmaceutical Sciences have to follow courses in food chemistry, with an emphasis on adulterations and their detection. The tendency is, however, to stress biomedical aspects at the expense of analytical aspects.

In the faculties of Agricultural Sciences, degrees in Agricultural Sciences and also in «Chemistry and Agricultural Industry» can be obtained. In both food chemistry is taught. The same holds for a post-graduate course in bio-industrial sciences.

The curricula of the faculties of Veterinary Medicine (Ghent, Liège) contain obligatory courses in the chemical analysis of food of animal origin.

For those veterinarians who want to become licenced in Veterinary Food Inspection there are additional courses in food chemistry.

In Antwerp there is an optional course with respect to xenobiotics in foods for students in chemistry.

In *Denmark* (21) the Veterinary and Agricultural University in Copenhagen (Frederiksberg) has specializations in Dairy Science and in Food Science. Presently the two lines of study are formally separate but with several courses in common. Dairy Science is 5 years, including a first year in the dairy industry at a technical

college. Food Science is 4.5 years, all at the University. Both lines begin with basic sciences such as mathematics, physics and particularly chemistry (general, physical, analytical and biochemistry). Microbiology and physiology are included as well. Apart from the subject matter the two lines then differ in the way that Food Science places more emphasis on nutrition and food microbiology and hygiene, whereas Dairy Science puts emphasis on technological aspects, although Food Science also ends up with technological courses.

Both lines lead to the equivalent of an M.Sc. degree. There is no structured B.Sc. degree. According to plans which are in progress, in future there will be one common bachelor degree (3 years) followed by two different master degrees (general food science and dairy science; 2 years each). A third 2-year master degree in human nutrition based on the same bachelor degree is also being planned.

At the Technical University in Copenhagen (Lyngby), chemical engineers may specialize in Food Science and Technology. During the 5-year curriculum approximately one year of courses in various branches of food sicence can be followed.

In future a closer cooperation, also on course level, is being anticipated between the two Universities.

The most relevant education in food chemistry and technology in *Norway* (22) is also at the Agricultural University (As). A student can choose for food technology, industrial food economy, dairy chemistry and technology, and dairy technology. The five years courses lead to the equivalent of a M.Sc. degree.

Tromsϕ has an education in fishery science which includes fish chemistry.

At the University of Oslo food and biological science is taught as a postdoctoral course.

The veterinary education, also at Oslo, contains a course in food hygiene which also includes chemical hygiene.

In *Sweden* (23), all students in chemistry can choose food chemistry, food technology or nutrition as part of their study.

Food science is taught, as one of the courses in applied chemistry, at the University of Lund, where biochemistry takes an important place in this curriculum.

At the Chalmers University of Technology, Göteborg, a departement of food science exists. This is part of the Chemistry Department and of one of the departments of Technical Chemistry.

The Swedish University of Agricultural sciences, Uppsala, has a Department of Agricultural and Food Chemistry, and a Department of Food Chemistry and Milk Products.

Finally, the National Food Administration at Uppsala teaches selected courses for the Uppsala and Stockholm universities in nutrition and toxicology for medical students. Food chemistry is included as well.

It is interesting to note that in *Finland* (24) two full curricula in Food Chemistry exist, i.e., at Helsinki and at Turku. The former curriculum belongs to the Helsinki University of Technology, Faculty of Agriculture and Forestry, whilst the latter is incorporated at the University of Turku, Faculty of Mathematics and Natural Sciences. In these curricula more than 40% is devoted to food chemistry. In Turku

there is also a strong emphasis on general chemistry and on biochemistry, whilst in Helsinki the education includes more of other branches of food science. In the Faculty of Agriculture and Forestry the curriculum in food chemistry leads to a degree in food science. The length of this curriculum is 160 study weeks of coursework and 20 study weeks towards a master's thesis, which means 4.5 to 5 years of study. A special feature in Turku is a close contact with the biochemistry curriculum. The length of the curriculum in Turku is 160 weeks as well.

At both universities, short courses in food chemistry are given as well for students of other curricula. The Faculty of Agriculture and Forestry (Helsinki) has a variety of chairs, e.g., food technology, cereal, milk and meat technology, food economics, nutrition and microbiology with their own curricula, where some short courses integrated with studies of food chemistry are given.

Structure

As is mentioned earlier, this overview is not complete, and for some European countries information is completely lacking. Nevertheless, the available data provide a rough indication of the unstructured situation regarding education and training in food chemistry. Obviously the source of this lack of structure lies in the absence of consensus or even consultation within Europe concerning these curricula. In contrast to this, a well-defined structure in food chemistry education has existed for almost hundred years in Germany.

In this context the standards for undergraduate education in food science and technology, developed by the U.S. Institute of Food Technologists (IFT) should be mentioned as well (25–27). These standards are recently discussed by *Fennema* (28) and are under revision now (29).

Whether or not a comparable situation in Europe is reached will depend on our ability to arrive at a collective description of our wishes and to know in what way these wishes can be realized. We have, therefore, to consult food industries which need for chemists, institutes working in food research, government services involved in food control, food production and foodstuffs, and other scientists performing research on foodstuffs.

Before such a journey is commenced, a clear idea about the structure of curricula and courses in food chemistry is imperative. Not more than a few headlines can be given here. It is obvious, however, that a complete food chemistry programme has to start with a thorough training in the fundamentals of chemistry, that is, teaching the students to understand chemical structure and chemical reactivity.

This means study of fundamental organic as well as inorganic chemistry, which must go further than teaching reaction mechanisms only. Chemical reactions usually take place in heterogeneous systems (such as foodstuffs), and are influenced by this heterogeneity. This is one of the reasons why physical chemistry merits an important place in the basic education. It needs no further explanation that biochemistry should be taught as well.

A sound base has to be laid from the beginning with respect to knowledge of and experience in analytical chemisty. This holds, to a certain extent, for any chemist, but is especially true for the food chemist because of the essential role of the chemical analysis in food science.

As for the training in analytical chemistry, it is not only the knowledge and performance of modern analytical methods that has to be taught, but also the organisation of analytical centres for the examination of foodstuffs and how to guarantee the quality of analysis. It should also be stressed that, in Europe, there is a strong tendency towards quality control of analysis.

It may be a matter of dispute whether a start should be made with basic sciences and the education be finished with the most applied subjects, or that the education should begin with food-oriented courses and basic sciences be taught later on in order to improve the understanding of the applied subjects. *Walstra* (30) is of the opinion that, for food technology, it is often the best to develop hybrid forms. In the experience of Koivistonen and Broman (Helsinki University of Technology) a more integrated approach, with some applied courses right from the beginning, may work better for reasons of student motivation, and that a reasonably close integration of basic sciences and professional courses give a far better possibility to understand the causal connections between the theoretical backgrounds and the applications. They agree, however, that a sound basis is necessary (31).

Starting from the German example (but without losing sight of other systems such as, for example, the M. Chem. A degree for public analysts in the United Kingdom (3)), I would suggest the following scheme:

– a thorough training in general chemistry during the first two years, completed by courses in physics, mathematics, statistics and biology, and including some introductory courses in food science;

– food chemistry in the next two years: application of acquired chemical knowledge to complicated systems such as food and raw materials, and the preparation of foodstuffs. Complementary courses have to be given in other relevant fields such as food technology, biotechnology, food microbiology, food physics, food toxicology, nutrition, botany, microscopy, sensoric analysis, knowledge of commodities, and food legislation. It would be very useful for two groups of food, e.g., one from plant and one from animal origin, to be considered in detail, as examples.

In the course of all four years the student should be trained in analytical chemistry. The analytical education should be extended from simple methods (but with a thorough consideration of basic principles and measurements) to exercises in modern techniques in the field of mass spectrometry, nuclear magnetic resonance, Fourier transformation infrared spectrometry, et cetera. For this purpose, short courses would have to be incorporated in the curriculum. In addition, screening methods and the application of a variety of probes deserve attention as well.

The importance of applied analytical chemistry cannot be overemphasized.

In the fifth and last year, a research project should be performed (at least for half a year) and an extended essay should be written.

The role of higher educated workers in production and handling of food

The role of experts trained in food chemistry can hardly be overemphasized. In the field of production and handling of food, however, there is also a need for many other people who have received a higher education in a variety of disciplines. This is summarized in Fig. 1.

The position of food scientists (other than food chemists) and food technologists will be clear. They all will be faced with chemical problems and, for that reason,

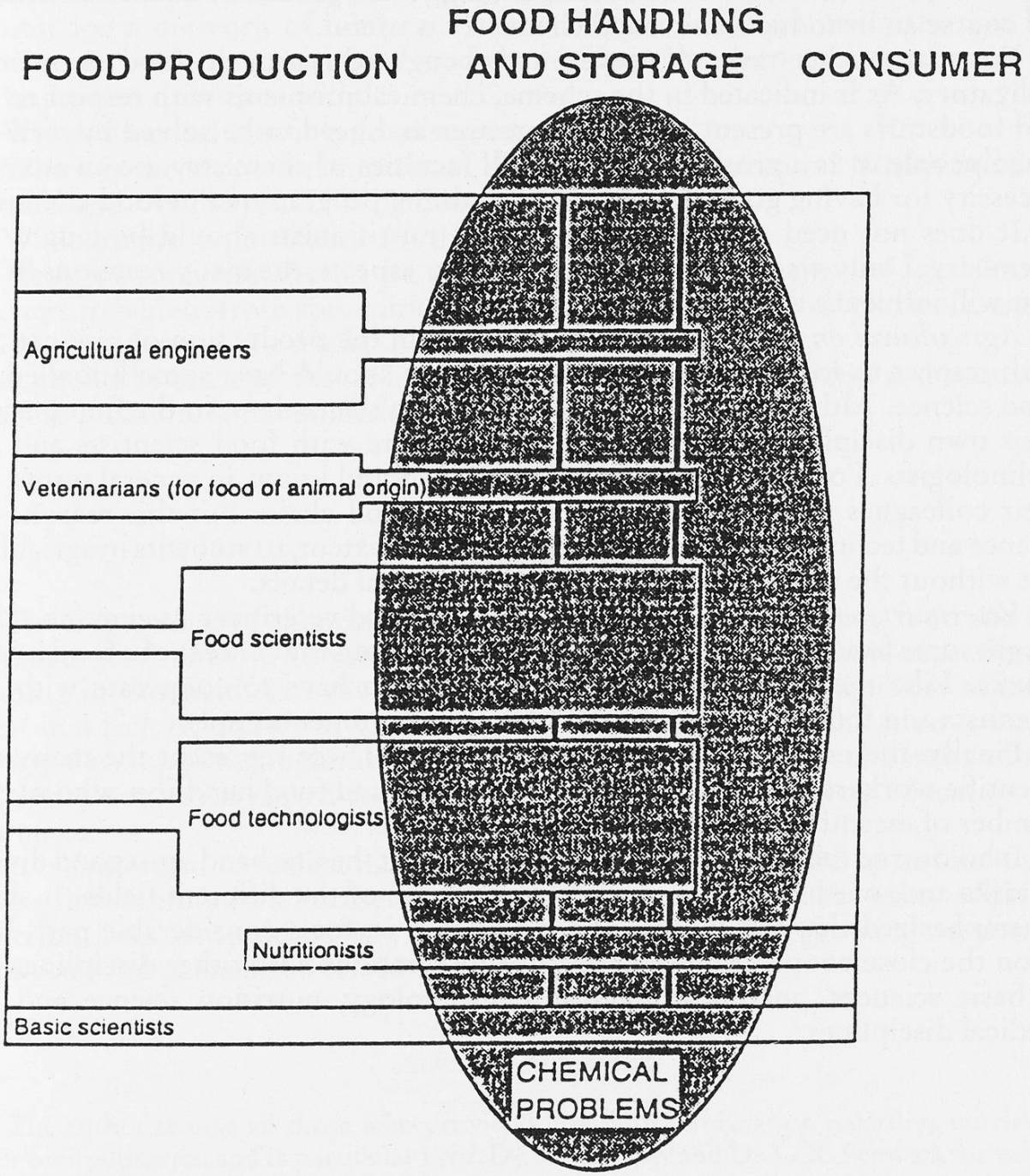

Fig. 1. Scheme presenting the role of engineers and scientists in the production and handling of food

should have knowledge of both basic and food chemistry. So, these disciplines should be present in their curriculum as well.

Next, the basic scientists. For a number of reasons fundamental research on food and foodstuffs is necessary. It is obvious that this research can be done by food chemists as far as it concerns chemical problems. It has to be stated, however, that food or food components are not fundamentally different from other natural compounds. Therefore a thorough training in food chemistry is not always necessary for these workers. Moreover, pharmacists, biologists and others can be involved in this field of research as well, depending on the problem under consideration. Of course an introduction in food chemistry is useful.

For many other tasks, however, a thorough education in food chemistry is obligatory. As is indicated in the scheme, chemical problems with respect to food and foodstuffs are present within a large area and need to be solved by well-educated people. It is a great pity that not all faculties of chemistry are aware of the necessity for having good education and training programmes in food chemistry.

It does not need much explanation that nutritionists should be taught food chemistry. I only want to stress, amongst other aspects, the many reactions in food that will influence the nutritional value.

Agricultural engineers are closely involved in the production of raw materials with respect to food preparation and therefore should have some knowledge of food science. Although they have to concentrate themselves, in the first place, on their own discipline, they also have to cooperate with food scientists and food technologists. For a fruitful cooperation they should know, in general terms, how their colleagues are involved in the extended food chain. For this reason, food science and technology have to be taught, to some extent, to students in agriculture, but without the necessity of going into all chemical details.

Veterinarians involved in animal production and veterinary hygiene should be taught some food chemistry as well, preferably within the context of a food hygiene course. Like the agricultural engineers, they also have to cooperate with food scientists and food technologists, and the same arguments apply.

Finally, the non-defined areas in the scheme. These represent the many non-scientific workers in the field of food production and food handling, who play the number of essential roles not discussed in this overview.

It holds true that a good cooperation is based, at the one hand, on a good division of tasks and, on the other, on mutual knowledge of the different fields. It should be emphasized that the success of food science is, for a considerable part, based upon the close cooperation (and perhaps integration) with other disciplines such as basic sciences, analytical chemistry, technology, nutrition science and even medical disciplines.

The need for food chemists

It is difficult to answer the question how many people who received a higher education or training in food chemistry are needed in Europe and how many students should get their diploma every year. For a country like The Netherlands this may be a number of 15 to 20 (based upon 300 to 350 food chemists actively working in the field). Of course we have to think about this during all our discussions with respect to this field. The first priority, however, is to ensure a good education in food chemistry throughout Europe in the near future. This, obviously, request for a network of contacts between universities and institutes that have courses or complete curricula in food chemistry in their programme.

Important questions will be:

- Which practical trainings, courses, etc. exist?
- Which is the scope and content of the theoretical education? Which books are used and which syllabi? Which lectures are given?
- What are the requirements for the examinations?

Next, possibilities should be investigated for the exchange of students and teachers to benefit from specialities which are not available in all curricula, and for broadening general knowledge.

It shoud be stressed that it is not necessary to make education and training as equal as possible. Some uniformity is, however, very useful.

Conclusion

The importance of chemistry in a number of matters concerning food and food products is without any doubt. This emphasizes the need for good education and training in this field. The diversity of educations in this field which is reflecting itself in a lack of uniformity indicates that, up till now, this education is insufficiently developed throughout Europe. A need exists for more cooperation in this discipline and, with regard to some countries, for more complete education programmes.

It is important to realize that this overview does not pretend to be much more than a first exploration. Further work regarding this matter needs many additional contributions. It would be very valuable if there could be a growing cooperation between food chemists involved in higher education.

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Summary

After a description of the field and the tasks of food chemistry, the possibilities for higher education in food chemistry in Europe are outlined. The situation in a number of European countries is compiled. The facts mentioned provide a rough indication of the many ways in which education in food chemistry takes place. The rather unstructured situation reflects the absence of consultation in Europe concerning this matter. In order to present an idea about the structure of curricula and courses in food chemistry a few headlines are mentioned with respect to a complete food chemistry programme. Finally, some thoughts are presented regarding the role of higher educated workers in production and handling of food and how they are involved in problems of a chemical character.

Zusammenfassung

Das Forschungsgebiet und der Aufgabenbereich der Lebensmittelchemie werden umschrieben und die Ausbildungsmöglichkeiten auf Hochschulstufe in Europa dargelegt. Die aktuelle Situation in einer Anzahl von europäischen Ländern wird dargestellt. Daraus werden die verschiedenen Wege ersichtlich, wie die Ausbildung in Lebensmittelchemie erfolgen kann. Die wenig aufeinander abgestimmte Situation zeigt einen Mangel an gegenseitiger Konsultation auf. Um eine Idee von der Struktur der Vorlesungen und Kurse in Lebensmittelchemie zu entwickeln, werden die wichtigsten Aspekte eines kompletten Ausbildungsprogrammes zusammengestellt. Schlussendlich werden einige Ideen präsentiert über die Rolle von ausgebildeten Mitarbeitern in Produktion und Handhabung von Lebensmitteln sowie ihre Involvierung in Probleme mit chemischen Aspekten.

Résumé

Le champ des recherches de la chimie alimentaire et les tâches qui lui sont assignées sont décrits ainsi que les possibilités de formation au niveau universitaire en Europe. La situation actuelle dans un certain nombre de pays européens est présentée. Les différentes voies de formation en chimie alimentaire sont décrites. Le peu d'harmonisation entre elles illustre le manque de consultation réciproque. Pour développer une conception de la structure des cours et travaux pratiques en chimie alimentaire, les aspects les plus importants d'un programme complet de formation sont récapitulés. Enfin quelques idées sont présentées sur le rôle que peuvent jouer des collaborateurs bien formés dans la production et la manipulation de denrées alimentaires ainsi que sur leur implication dans des problèmes présentant des aspects chimiques.

Literature

1. *Högl, O.:* Aufgaben und Probleme der Lebensmittelwissenschaft. In Schormüller, J. (ed.), Handbuch der Lebensmittelchemie. Band I: Die Bestandteile der Lebensmittel, S. 76–99. Springer-Verlag Berlin/Heidelberg/New York 1965.
2. *Thier, H.-P.:* Personal communications.
3. *Martin, P.G.:* Public analyst in the United Kingdom. Proc. Euro Food Chem. VI, Hamburg, pp. 51–58. B. Behr's Verlag, GmbH & Co., Hamburg 1991.

4. *Walstra, P.* and *Prins, A.:* Inaugural lectures Agricultural University, Wageningen 1978.
5. *Bruin, B., Hallström, B.* and *Jowitt, R.:* Food process engineering – a model syllabus. J. Food Eng. **3,** 205–223 (1984).
6. *Battaglia, R.:* Personal communication.
7. *Czedik-Eysenberg, P.B.* and *Pfannhauser, W.:* Personal communications.
8. *Davidek, J.:* Personal communication.
9. *Lasztity, R.:* Personal communication.
10. *Wilska-Jeszka, J.:* Personal communication.
11. *Kratchanov, Ch.:* Personal communication.
12. *Petrovic, I.:* Personal communication.
13. *Wedzicha, B.L.:* Food science and technology with hotels, catering and tourism in UK universities, polytechnics and colleges. Degree course guide 1990/1991. G.R. Fenwick, personal communication.
14. Association européenne des établissements d'enseignement vétérinaire (A.E.E.E.V.), Curricula – Document réalisé avec l'aide de la Commission des Communautés Européennes dans le cadre du programme Erasmus, 1989.
15. *Fox, P.F.:* Personal communication.
16. *Ducauze, Ch.:* Personal communication.
17. *Marchelli, R.:* Personal communication.
18. *Benedito de Barber, C.:* Personal communication.
19. *Deelstra, H.:* Personal communication.
20. *Empis, J.:* Personal communication.
21. *Storgaard Jorgensen, S.:* Personal communication.
22. *Russwurm, H.:* Personal communication.
23. *Reio, L.:* Personal communication.
24. *Linko, R.* and *Wallin, H.:* Personal communication.
25. Anonymous – Conference on undergraduate education in food science and technology. Food Technology **16** (8), 42, 44, 46 (1962).
26. Anonymous – IFT council adopts undergraduate curriculum minimum standards. Food Technology **20** (12), 61–63 (1966).
27. Anonymous – IFT undergraduate curriculum minimum standards. Food Technology **31** (10), 60–61 (1977), **44** (2), 32–33, 40 (1990).
28. *Fennema, O.:* Education programs in food science: a continuing struggle for legitimacy, respect and recognition. Food Technology **43** (9), 170–172, 174–176, 178, 180–182 (1989).
29. *Hopper, P.F.:* New goals for food science education. Food Technology **44** (2), 12 (1990).
30. *Walstra, P.:* University education in food technology: the various philosophies. Lecture held at the 2nd EFFoST conference, Brussels, April 1991.
31. *Koivistoinen, P.* and *Broman, U.-I.:* Personal communication through H. Wallin.

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