# Advances in Flavor Research and Technology

## A Report on the Rutgers' Symposium, April 24, 1991

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The fourth bi-annual Symposium on Advances in Flavor Research and Technology took place at the Sheraton Towers in Iselin, New Jersey on April 24, 1991. Professor Chi-Tang Ho and Henry V. Izzo, Rutgers University, and Dr. James T. Carlin, Joseph Seagrams and Sons Inc., put together a wide-ranging program with international participation that attracted about 215 scientists mainly from the flavor, food and beverage industry.

The ten speakers coming from Germany, Great Britain, Switzerland and the U.S. discussed developments covering areas from the analysis of volatile materials, isotopic analysis, reaction flavors, biotechnology, fruit essence processing, encapsulation of flavors through to new Food & Drug Administration (FDA) labeling rules, marketing of new products and the role and importance of the flavor industry trade organization.

It is very difficult to completely cover all contributions in a condensed form and the following is the writer's attempt at an unbiased interpretation.

In his opening and welcoming remarks, **Dr. M. Solberg**, director of the Center of Advanced Food Technology (CAFT) at *Rutgers University* gave a short overview on the research activities of their center and the possibilities offered to conduct experiments for outside research. Spectroscopy, and especially mass-spectrometry, are available for a fee on a service basis. Technology transfer programs exist, mainly oriented to provide assistance to small- and medium-sized New Jersey companies. The main component in this program is the availability of a well-equipped, versatile Pilot Plant that is made available for a minimal fee to these companies.

Regulatory aspects in food-related areas are very important and are becoming very complex, both for international and national interest and considerations. Dr. Charles H. Manley, Takasago International Corporation, member of the Board of Governors of the Flavor and Extract Manufacturers Association (FEMA) explained the important role that this organization plays in assuring the safety and quality of flavors by establishing standards and promoting laws and regulations, and at the same time protecting the proper interest of the industry.

FEMA is a trade organization that comprises 108 company members, both producers and users of flavor materials. The main tasks of the organization are membership services, safety reviews of flavor materials and legislative and regulatory surveys.

The major accomplishment of FEMA is certainly the establishment of the so-called Generally Recognized as Safe (GRAS) concept. This concept is based on a method which evaluates the potential risk of a compound originating from the "decision-tree-approach," and the consumption ratio, an index relating the exposure of added and naturally found compounds of the same chemical structure. Using this procedure, an independent expert panel establishes a risk assessment of compounds used in the flavor industry.

FEMA also coordinates the international relations of the industry, international organizations and regulatory bodies like the European Community, the World Health Organization and the Food and Agricultural Organization.

**Klaus Bauer**, *Dragoco, Inc.*, explained the "Dynamics and Impact of Flavor Labeling," the sometimes confusing interpretations of FDA's Advanced Notice of Proposed Rule-making of August 8, 1989 concerning the revised labeling of food products in relation to flavors. Actually, Flavor Labeling Regulations of December 3, 1973, still in effect, are quite explicit and straightforward. 21 CFR Paragraph 101.22(i) through 101.22(i)(3)(iii) distinguishes between eight different labeling categories for flavors, the explanations of which are given in the corresponding preambles. These eight categories are: characterizing flavors, i.e., a chemical that approximates flavor characteristics of

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key flavor notes; natural flavor that characterizes a food; natural characterizing flavor to which other natural materials have been added; artificial characterizing flavors; characterizing food ingredients (e.g., strawberries in a strawberry shortcake); characterizing food ingredients to which other natural flavors have been added; flavors that do not contain any ingredients of the described food but have taste characteristics that are named, e.g., beef-type flavor; and last, three or more distinguishable characterizing flavors may be described as punch. It would go far beyond the scope of this article to go into more detail of these regulations. A short mention of the new European Council directives were also given by the speaker.

Two lectures dealt with the analysis of volatile aroma compounds. **Dr. Ivon Flament**, *Firmenich SA*, Geneva, described the application of headspace analysis for the identification of the flavor impact compounds of black truffles. The headspace technique, first used in 1960, enjoys a certain renaissance, because the number of publications mentioning it (if this is a useful measure) has doubled every five years since then. The technique allows a nondestructive analysis of volatile compounds, e.g., monitoring the emission of live flowers or fruits over time. This technique was termed by Flament as "Chronochromatography." The application to black truffles identified 135 new constituents in this fungus. Many desirable aroma notes of this highly appreciated food could be attributed to identified compounds. A series of 17 methoxybenzenes seem to be very important for a good truffle flavor. An interesting footnote is the fact that the old German and French saying that "money has no odor" has become invalid. A headspace analysis of about eight new Ten-Swiss-Franc notes showed quite a series of volatiles with olfactive activities!

**Dr. M. Guntert**, *Haarmann & Reimer GmbH*, discussed the very difficult analysis of volatile flavor materials obtained from processed flavors, heated yeast extracts, as well as model Maillard reactions. The analyses were carried out using the most sophisticated separation, isolation and identification methods available today. Thermal degradation of thiamin, vitamin $B_1$, which is an important precursor for meat flavors gave some 27 sulfur-containing, organoleptically-active compounds. Yeast extracts that contain about 1-2% of thiamin, yielded, on heating, 115 sulfur compounds, including 47 differently alkylated dithianes. This work shows that there are still many new structures with organoleptically interesting notes to be discovered, and also sheds some insight into the chemical mechanism of formation of meat flavor during heating.

Biotechnology has become very important in many fields of science, and **Dr. Juan Mor**, *Givaudan Research*, Dübendorf, Switzerland, gave a general summary of the applications of biotechnology in the food industry and especially for the production of flavors. Biotechnology and foods has a long, historical relationship, however, its use for specifically making flavors is still in an early phase and many developments can be expected in the future.

Biotechnological methods can be separated into two categories: the use of enzymes and the use of whole cells. Whole cells can be used to produce chemicals completely using a feedstock, or to specifically transform given chemicals. Flavor producing microorganisms can be bacteria, yeast and molds, making either some selected flavoring compounds or whole flavor systems. Plant cell cultures, still having some technical drawbacks compared to microbial cell cultures, will be one of the methods of choice for the future; some examples were given of commercially available products made with this technique of which the production of vanilla flavor will certainly be of great commercial interest.

Use of biotechnology, per se, or in combination with heat processing to create natural dairy flavors was discussed by **Dr. David Josephson**, *Fries & Fries*. The different components of milk, i.e., cream, fat, casein, lactose, can be obtained by physical separation and can be used as such or as precursors for flavors. Biological manipulation of milk, as it has been done for centuries to make products like yogurt and cheese, can be modified to increase the amount of flavoring materials produced.

Lactose is a good feedstock for fermentation and the metabolites are useful flavoring materials. Milk proteins, i.e., casein, can be hydrolyzed to amino acids and oligopeptides, compounds known to impart mouthfeel. Milk fat can act as a solvent for flavor materials, as well as precursor for the formation of lactones, ketones and specific fatty acids, all part of the aroma of dairy products.

One interesting observation, that again shows that flavor chemistry can be full of surprises, are the thresholds of three related fatty acids occurring in milk fat: octanoic acid, 4-methyl-octanoic acid, and 4-ethyloctanoic acid have values of 8700 ppb, 400 ppb and 1.8 ppb respectively.

The right combinations of different reaction parameters, both biochemically and chemically, allow the directed production of enhanced dairy flavors. The main parameters are the use of specific lipase and protease systems, pH adjustments and heat treatment. Considering all the possible variations of these parameters, one can expect many more flavors to be developed.

The economic importance of natural flavors has attracted adulterations. To cope with this situation, many methods have been developed to identify these counterfeits; one of the most important ones is based on the ratio of carbon isotopes. **Dr. George Collins**, *Finnigan MAT Company*, presented a very sensitive method based on this principle, allowing the isotope analysis of nearly every peak in the gas chromatogram of a flavor.

The elute of a capillary column is burned in a combustion chamber of about 6 µl volume and the resulting carbon dioxide is analyzed by mass spectroscopy for the ratio of the masses 44 ($^{12}CO_2$), 45 ($^{13}CO_2$); 46 ($^{12}C^{16}O^{18}O$). The dynamic range of the instrument is about 100, thus allowing the analysis of peaks down to 1% of the main constituent; and the reproducibility is about 0.001% (abs).

Because this procedure allows the simultaneous analysis of nearly every peak, it can detect adulterations made by addition of $^{13}C$ enriched materials, because it would not only show the petrol-based, $^{13}C$ poor compounds, but also the overly enriched, added compound. From the total ratio, one can even calculate the degree of adulteration per peak, so those who want to "embellish their natural" flavors a little bit, better watch out!

Citrus is one of the most important types of flavors and many technologies exist for the extraction and concentration of orange oil. **David Moyler**, *Universal Flavors Ltd.*, described a procedure for obtaining a highly concentrated soluble orange flavor using counter current extraction procedures. The cited advantages of the procedure are mainly the efficiency of deterpenation at temperatures that do not harm the highly volatile trace compounds that are very important for imparting the freshly-squeezed orange flavor.

Flavors and flavor ingredients are only useful if they perform in given applications. This problem was again stressed by **Dr. William Bangs**, *Campbell Soup Co.*, who talked about "Developments in Flavor Encapsulations." The fundamental problem is: how to protect a flavor during processing and storage of food materials, yet have it liberated to be active during consumption. Many different methods and systems for encapsulation exist, e.g., spray drying, plating, hot melts, sugar melts, coacervates, vacuum drying. All of them have their use but are also limited to specific applications. The search is for the universal "Flavor Fix," a procedure that has high flavor load, does not partition out, has general applicability and, last but not least, is cost effective.

"Lost Illusions - Found Money" was the title of the talk of **Gerald Schoenfeld**, *Schoenfeld Chapman & Pearl Inc.*, who, in a very entertaining way, explained the to-do's and especially the not-to-do's in today's marketing of consumer products. Citing some well-known products and their more or less successful introduction, the following fundamental advice came up: In marketing, a so-called wisdom does not exist, challenge the unknown, never say never, there is no 'no-no' in this world. Consumers are much smarter than expected. Unexamined premises can be misleading. The four principle counsels that Mr. Schoenfeld gave to the audience were:

- go back into the past, analyze successes;
- use the present, see what is existing, check successful competitors' products;
- consider the future, develop ideas; and

- be aware of preconceived ideas, if there is a premise, examine it.

## Conclusions

To cover all disciplines that encompass flavor research in a one-day symposium is impossible. However, some conclusions on the directions in which flavor research is moving today can be drawn.

The first observation is that all contributions to this symposium came from industrial institutions. Is it coincidental or does it mean that flavor research has outgrown its basics, no more general, fundamental research is needed, or at least worthwhile to be undertaken? I personally do not think so, but it is quite obvious that the main emphasis has shifted considerably during the last five to seven years. The field has broadened enormously and expanded beyond very detailed analytical studies of aroma volatiles. There are many reasons for this change and one can easily identify three main groups that lead into new areas of reseach (see Table I).

**Table I.**
**Three main areas of research in flavor technology**

| Reasons | Needs | Research Areas |
|---|---|---|
| Marketing<br>Labeling<br>Legal status | Natural Flavors | Biotechnology<br>Extraction Procedures<br>Analytical methods to identify frauds |
| Shelf life extensions | New applications<br>New processing conditions | Tailor-made flavors<br>New application forms |
| New functional ingredients<br>Low caloric fat and sugar replacers | Sensory simulation of classical food ingredients | New "flavors" for imparting mouthfeel and tactile sensations |
| Flavor is aroma <u>and</u> taste | More complete flavor systems | Reaction flavors<br>Extraction procedures<br>Biotechnology<br>Analysis of nonvolatile taste compounds |

The trend to using natural flavors, initiated to better market food products, is the main reason for using biotechnology in flavor research. New extraction procedures are developed to extract organoleptically active compounds from natural sources more specifically and more efficiently. Because of the economic importance of natural flavors, methods have to be developed to control and assure the integrity of the product.

The development of new food products using new processes leads to the need for new flavor systems. New application forms are becoming very important for these systems, in the development of new functional ingredients, consumers accept these with enthusiasm if the known organoleptic qualities are provided, e.g., fat replacers, sweetners and salt replacers. It is a very important field in flavor research to find flavors that impart the "good" sensation using replacement materials. This is in line with the fact that flavor is more than just volatiles. It is aroma and taste. Flavors are expected to deliver these impacts, leading to the research into complete reaction flavors, more efficient extraction procedures, use of biotechnology, and new analytical methods that allow investigation into non- and low-volatile materials that are of importance for the overall flavor. It is obvious that many efforts are directed into these fields. We know the chemistry of aroma compounds relatively well. In order to better apply these chemicals to make our food even more delicious, we have to learn to understand why they do what they do, under given conditions.

It was an interesting day with stimulating contributions, and I am looking forward to the fifth edition of the Rutgers Flavor Symposium.

**Reference**

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