Flavours and Fragrances

Chemistry, Bioprocessing and Sustainability

R. G. Berger (Ed.)

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With 231 Figures and 61 Tables

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Preface

Our ancestors lived in intimacy with nature and knew well that their survival depended on a safe and fertile environment. The introduction of three-field rotation in the eighth century bc, for example, counteracted the depletion of soil and increased crop yields without negative side effects. The first definition of the modern term "sustainability" is usually ascribed to forest chief captain H. C. von Carlowitz, who in 1713 in his *Sylvicultura Oeconomica* formulated principles for a sensible economy of wood. From J. S. Mill (*Of the Stationary State*) to modern academic representatives, such as K. Boulding, D. E. Meadows (*The Limits to Growth*), R. Easterlin and H. E. Daly, the "ecological economists" have remained a concerned but rather ignored minority. The situation started to change after the famous Brundtland report (*Our Common Future*) of the UN defined sustainability as a desirable characteristic of development, which will not only meet current needs of people, but also will not jeopardise the ability of future generations to meet their demands and to choose their style of life. This definition includes a social dimension and was also adopted by Agenda 21 of the UNCED in 1992 in Rio de Janeiro.

A set of rules may aid in assessing the sustainable quality of a process:

- Consumption and regeneration of the raw materials should be balanced.
- Non-regenerative goods should be replaced.
- Generation of waste and its biological elimination should be balanced.
- Technical processes should match biological processes on the time scale.

A merely growth oriented economy must violate these rules. According to the first law of thermodynamics, energy in a closed system like the planet earth is finite (if we neglect the solar photon flux). Today mankind secures its survival by exploiting low-entropy resources, such as fossil fuels, concentrated minerals and higher plants, and by converting them to high-entropy products, such as carbon dioxide, cars and fine chemicals. However, as proven by our office desks, high entropy levels can only be lowered by energy input. Here the first and the second law of thermodynamics collide, and we apparently encounter the inner core of the conflict.

With the world running out of crude oil, species dying out at an alarming rate and political leaders seemingly little concerned about the predicted disasters, scientists should feel challenged to suggest solutions. A sustainable production

of natural flavours, like wood, fats and oils, saccharides, phytomedicines, bioethanol, biopolymers and natural colours, mainly depends on the existence of reliable plant sources. But how long will the traditional sources of flavours last? Quality of soil, unfavourable weather conditions, insect infestations and sociopolitical instabilities may all adversely affect classical agricultural production. Are there new biosources that could replace exhausted ones? Will, as with vanillin production, the exploitation of waste streams of the agricultural and food industries gain importance? "White biotechnology" is propagated as an alternative option, but will bioprocesses possess stability, specificity, up-scalability and profitability? Will the recent advances in biotechnology be successfully transferred to industrial scales? How can the aspired match of economy and ecology be achieved?

In an attempt to compile the current status of sustainability in the flavour industry and the developments in the foreseeable future of flavour production, the present volume discusses consumer trends and preferences, legal and safety aspects; it describes renewable resources of flavours, such as spice plants, fruits, vegetables, fermented and heated plants, and natural building blocks; it presents analytical methods, such as gas chromatography coupled to human or electronic noses or to mass spectrometers; it deals with the isolation, quality control and formulation of flavours for liquid or dry products, with biotechnology to provide novel renewable resources, with enzymes, microbial and fungal cells to biotransform cheap substrates or to produce flavours de novo, and with plant cells as a resource of genes coding for metabolic activities in transgenic producers.

The manufacturers of flavours and fragrances and their scientists are working at the leading edge of research, they look back on a long history of using natural resources, and are profitable on the basis of renewables. A wealth of experience has been gathered on issues such as provenance and quality, safety, authenticity and on problems of isolation, processing and shelf life. On the basis of this fundament of knowledge, we should start to deal with sustainability now, before the looming problems start to deal with us.

Finally, I should like to express my sincere thanks to the contributors for their thoughts and writing efforts, and to the publishers for their continuing support and patience.

Hanover, Summer 2006 Ralf Günter Berger

Contents

1 The Flavour and Fragrance Industry—Past, Present, and Future

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The origin of using odorous substances simply for enjoyment or medicinal reasons is as old as mankind. People have used perfume oils, and unguents on their bodies for thousands of years in lesser or greater amounts dependent on fashion whims. The early Egyptians used perfumed balms as part of religious ceremonies and later as part of pre-love-making preparations. Myrrh and frankincense were exuded gums from trees used to scent the atmosphere in rituals. Other plants such as rose and peppermint were steeped in oils until a perfumed unguent formed. The unguent was then rubbed into the skin. It is interesting to note that perfume has come full circle today as more and more of us seek out high-quality aroma therapy perfumed oils to use in exactly the same way as our ancestors did. Perfume fell out of use during early Christianity, but was revived in the medieval period. By the 1600s scents were applied to objects such as furniture, gloves, and fans. In the Georgian era non-greasy eau de Cologne was developed and it had many uses from bath essence to mouthwash [1].

People have always been interested in the odour and use of essential oils (from herbs and spices). This is probably attributable to their aromas, and also to the bacteriostatic and antiseptic properties of many of the aroma chemicals they contain. While the use of essential oils is associated with mankind's history, the beginning of perfumery is more difficult to define.

The late nineteenth century was the first real era of perfume as we know it when new scents were created because of advances in organic chemistry knowledge. Synthetic perfume products were used in place of certain hard-to-find or expensive ingredients. At the same time a similar chemical knowledge development happened in textile printing dyes. The small town of Grasse in Provence, France, became a centre for flower and herb growing for the perfume industry. The men who treated leathers in the same area found the smells so bad they perfumed themselves and the leathers. They were knowledgeable about making the botanical essences and were the early perfume noses. But it was only in the twentieth century that scents and designer perfumes were really mass-produced. Before that, the few trade names that existed were Coty and Yardley, who made fairly light scents with familiar smells.

Obviously, these first perfumes were all natural, since the introduction of synthetic aroma chemicals happened only at the end of the nineteenth century. Along with the invention of certain aroma chemicals, the flavour and fragrance

industry originated more than 150 years ago, at a time that is in general characterised by significant technological breakthroughs, largely in chemistry. At that time, the first flavour and fragrance companies were founded by entrepreneurial scientists or business people, and many still exist, either as such or as the nucleus of larger firms that evolved during the subsequent decades.

Over the years this industry has developed into a very profitable niche market. It serves retail companies in the food and beverage, cosmetics, toiletry, and household products markets, as well as the fragrance industries. Food service and private label companies play an increasingly significant role in this business. The total market for flavours, fragrances, and cosmetic ingredients is estimated at €15 billion. The market shares between the flavour and the fragrance parts are almost equal (€6.5 billion for flavours, €6.5 billion for fragrances). The largest markets are in the Europe, Africa, and Middle East region (36%) and North America (32%), followed by Asia-Pacific (26%) and South America (6%). Interesting emerging markets are, in particular, China, India, Russia, and Central America. There are eight major global companies that share about 60% of the world market. Aside from these multinationals—well-known names to insiders—there are virtually hundreds of smaller companies specialising in certain segments of this business covering the other half of the market. The two largest flavour and fragrance companies are Givaudan and International Flavors & Fragrances, followed by Firmenich and Symrise, Quest International, Takasago, T. Hasegawa, Sensient Technologies, Mastertaste, Danisco, and Mane. The top two companies have a turnover in excess of $2 billion, the next three companies have a turnover in excess of $1 billion each. For respective information on the flavour and fragrance business and the companies, readers are referred to [2]. Another good and recently published source of information on flavours and fragrances is [3]. The latest development of the industry happened just at the end of 2006 when Givaudan announced that they will acquire Quest International. In the following, the history and achievements of some of the companies are described.

In 1993, Bell Flavors & Fragrances acquired the operations of the former firm Schimmel & Co. in Leipzig, Germany. This company, originally founded in 1829, is considered the founding firm of the flavour and fragrance industry. The scientific accomplishments developed at Schimmel formed the basis for the technology still used in the industry today. Works such as *The Encyclopedia of Essential Oils*, published by doctors Gildemeister and Hoffmann in 1899 and *The Theory of the Extraction and Separation of Essential Oils by way of Distillation*, published by Carl V. Rechenberg in 1908, became the standards for the production and use of these products. Outstanding achievement in the field of terpene chemistry was recognised when Otto Wallach received the Nobel Prize in Chemistry in 1910 [4].

In 1874, Holzminden chemists Ferdinand Tiemann and Wilhelm Haarmann first succeeded in synthesising vanillin from coniferin. Holzminden became the site where vanillin was first produced industrially. Haarmann & Reimer was the world's first factory in which synthetic scents and flavourings were produced [5].

Milestones Haarmann & Reimer:

1874 Haarmann & Reimer founded in Holzminden; industrial production of aroma chemicals.
1953 Acquisition by Bayer AG in Leverkusen, Germany.
1990 Company expands via acquisitions, including Creations Aromatiques and Florasynth.
1998 Improvement of margin and performance; focus on major clients and emerging markets; key account management; centres of expertise created; regionalisation and market-oriented innovation management.
2003 Merger of Holzminden companies Haarmann & Reimer and Dragoco. A new corporation is formed: Symrise.

Milestones Dragoco:

1919 Family business founded in Holzminden, Germany, by Carl-Wilhelm Gerberding.
1930 Flavourings first produced.
1949 Aroma chemicals first produced.
1955 Carl-Heinz Gerberding becomes CEO; company expands internationally and focuses on independence and profitability.
1981 Horst-Otto Gerberding becomes CEO; extensive investment programme for regional centres; implementation of a global divisional organisation.
1993 The Dragoco group is restructured and the parent company is turned into a joint-stock company.
2003 Merger of Holzminden companies Haarmann & Reimer and Dragoco. A new corporation is formed: Symrise. The latest milestone of the new company Symrise has been reached at the end of 2006 when the company became publicly traded.

Firmenich was founded in 1895 in Geneva, by Philippe Chuit, a talented Swiss chemist, in association with Martin Naef, a shrewd businessman. They were joined shortly after by Fred Firmenich, who soon became the majority partner. Since then, Firmenich has remained a family-owned business, building on a solid foundation of pioneering and entrepreneurial vigour. Today, it is the world's largest private company in the fragrance and flavour industry worldwide. Since 1895, Firmenich has built its business on innovative research. Leopold Ruzicka, professor at ETH-Zurich and Nobel Prize winner in 1939, was Firmenich's first research director and a life-long consultant [6].

The history of Givaudan [7)], International Flavors & Fragrances [8] and Quest International [9] can be looked up at their respectively cited Web sites.

The flavour and fragrance business has always been very research driven and innovative. All larger companies spend about 7–8% of their total sales per annum on research and development. They all have large research centres, usually centred in their headquarters, as well as development and innovation centres around the globe. The general focus of their research is on new products, offering better performance at the lowest cost. This can be new molecules but also a new technique to concentrate (fold) a citrus oil, or a new way to encapsu-

late a flavour or fragrance. New products must be innovative, environmentally friendly, and safe. The key to success nowadays is to bring these new research results to market as quickly as possible; therefore, the major companies all use the concept of the innovation funnel to ensure proper project management and efficient commercialisation of innovative ideas. Strong research only pays off in combination with innovative flavour and fragrance chemists (flavourists and perfumers) as well as strong application teams in combination with technical marketing. In addition, all major companies use worldwide IT systems to enable their product developers and regulatory people to work with a consistent set of raw materials and product formulas on a worldwide basis.

Flavourists and perfumers are professionals engaged in the study and exploitation of materials capable of impacting the human senses of taste, smell, and chemesthesis. Flavourists work primarily with substances that are either derived (directly or indirectly) from plant or animal sources or chemically synthesised from petrochemicals to develop products intended for use in foods and beverages. Perfumers work mostly with materials of plant, animal, or petrochemical origin to create perfumes, fragranced personal care products, and scented household goods.

Research carried out by flavour and fragrance companies is generally for the purpose of understanding, designing, or improving upon the sensory characteristics and/or the functionality of existing or new products. This often starts with the detailed chemical analysis of a specific target: a finished product or raw materials used in its manufacture. Creative flavourists or perfumers, respectively, with the help of product technologists, may then try to reconstitute flavours or fragrances that match or improve upon the sensory properties of the target. In the case of flavourists, matching a specific natural or processed food or beverage is usually the objective, while a perfumer often has more latitude in cases where the target fine perfume or household air freshener, for example, may be little more than a marketing concept. Product technologists help ensure that flavours and fragrances are stable in products and are released effectively and are therefore perceivable at the time of consumption or use. Results of chemical analysis may alternatively be used. For example, to design better flavour or fragrance molecules; to make improvements in ingredient formulations or manufacturing processes. It can be mentioned here that the instrumental analysis part in the major flavour and fragrance companies is very sophisticated and remarkable. The typical instrumentation ranges from capillary gas chromatography (GC) to high-performance liquid chromatography (HPLC), Fourier transform IR spectroscopy (FTIR), and nuclear magnetic resonance (NMR) to coupled techniques like capillary GC–mass spectrometry (MS), HPLC-MS, and GC-FTIR. More recent advances are the coupled techniques GC-MS-MS as well as HPLC-NMR. This enables industry to separate virtually all kinds of complex product mixes analytically and also to elucidate the chemical structures of unknown components. Needless to say that a lot of year-long experience and know-how is involved when it comes to research and development in flavour and fragrance companies (personal communication within Symrise).

Although the industry is about 150 years old, in particular the use of synthetic materials started only about 60 years ago, after World War II. In 1954, the flavour use of coumarin was banned by the FDA, television screens were small and round and only showed black-and-white pictures, and a fine house could be purchased for less than $17,000. It would be 4 years until Congress enacted the Food Additives Amendment of 1958 and both the FDA and the Flavour and Extract Manufacturer's Association began developing the generally recognised as safe (GRAS) lists. The first commercial production of synthetic linalool, geraniol, and derivatives had not yet started. Fewer than 500 volatile components had been found in foodstuffs. In 1955 the first primitive commercial gas chromatograph was introduced and it would be about 15 years later before the full power of capillary GC-MS became practical and another 15 years with the use of computerised data bases. Only four of the five basic tastes were generally accepted and theories of olfaction were extremely theoretical. Chirality was rarely considered as important in the synthesis of flavour or fragrance chemicals. Much has occurred in the last 50 years [10]. In a slightly different way, the development of the last about 50 years is shown in Fig. 1.1. The flavours used in the 1950s were mostly liquid. They consisted of natural extracts and essential oils. The first big paradigm shift happened in the 1960s when several developments happened at the same time. The first synthetic components started being used, while instrumental analysis and information technology began influencing the flavour and fragrance industry. Spray-dried flavours were developed and the food market started to embrace convenience food. The big era of analytical flavour research started at that time, characterised by many scientific publications and patents in subsequent years. The next big change happened in the 1990s when research started to become a lot more applications-driven. Flavour release and integrated product concepts played a role, and food-on-the-go was developed. In the new century the term "productivity" came up, a clear sign that shrinking margins led to the consolidation of the food companies and the search for more cost-effective ingredients and flavours. Taste and taste modifications as well as mouth sensations became prevalent. Sensory started becoming consumer research, and health aspects played into product development. This is the phase the industry is still in, and we will see when the next paradigm shift is going to happen. Nowadays the palettes of a perfumer and flavourists are fully developed. There are still new aroma chemicals entering the market every year but the number is certainly smaller compared with that 10–20 years ago, and the organoleptical differences of these new molecules from known ones are typically smaller, which means business success is usually and primarily not built anymore solely on new molecules. At the same time the typical analytical research from the end of the last century that was going on in all large flavour and fragrance companies with the goal to analyse natural materials (preferably foods, essential oils, and flower scents) and find new molecules that could be synthesised and used as nature-identical materials in new compositions is not the main focus anymore. Nowadays research is a lot more applications-driven. Innovation happens foremost at the finished-product level; hence, flavour and fragrance companies work a lot closer together with their large consumer-goods

customers and in many cases have taken on a part of the work that used to be done in their laboratories. On the flavour side, research on taste and taste modification has become a lot more important than the work on volatile materials. Topics like salt taste enhancement or sweetness enhancement prevail. Mastering the flavour release in various applications and encapsulating liquid flavours with different matrices to keep even critical ingredients (e.g. citrus) stable for up to 4 years have opened the door for different food and beverage concepts and have also helped to make the food business more global and more convenience-driven than it ever was before. The ideal scenario today in flavour and fragrance research is to find a new molecule whose structure can be patented and used in a new formulation that helps to improve an application for a consumer-goods company significantly. The application can be everything from a cosmetic product to a household article to seasoning for a potato chip or a canned coffee product (personal communication within Symrise).

"Sustainable development" describes and stands for the policy of a company of how it conducts business, treats its employees and resources, and interacts with society and the environment. It is basically the corporate philosophy around the pillars ecology, economy, and society. There are many other phrases and acronyms for more or less the same type of activity used. The most common one is corporate social responsibility (CSR). Sustainable development has become an important initiative for many industries and companies over the last few years. Many chemical companies have started a sustainable development initiative over the last few years. Strong points in there are the environmental/ecological aspects as well as the workers' safety programmes. It is a distinct sign that the industry has learned to deal with its weaknesses in a much more offensive way than in the first decades after World War II when major environmental crises represented for the public how the industry operated. One example is the little town of Seveso in the industrialised north of Italy. It was heavily affected in 1976 when a major chemical accident led to the outbreak of chlorine gas and dioxins into the environment. Since those years, the chemical industry has invested a lot and has learned significantly more about how to manufacture even hazardous materials in such a way that this type of crisis is prevented from happening. In addition, chemical waste is treated differently, energy is used a lot more economically, and odours are prevented from being released.

The flavour and fragrance industry's weak points from an environmental/ecological point of view evidently are, in particular, odour emissions, the handling of chemicals and chemical reactions in manufacturing, and the handling of wastewater. Every company that has started sustainable development activities has looked at its weak (vulnerable) points. Their statements show that the sustainable development programme is used to turn weaknesses into strengths or at least show work being done continuously on these weak points. By looking at the pillar "society", another challenge becomes apparent. While it seems to be obvious for most consumers why pharmaceuticals are needed and beneficial, the use of flavours for foods and beverages as well as fragrances for various ap-

plications is not so easily understood by a certain part of the population. Unfortunately, this is sometimes abused by certain authors in common publications when flavours are described as potential risks for humans and fragrances are classified as luxury goods or simply unnecessary and annoying. Therefore, it is important to educate the population about the safety of flavour and fragrances and the benefits for their use in consumer products. Obviously, this attempt is complicated by the fact that the flavour and fragrance industry does not usually deal directly with consumers.

In the following a few activities are listed that can be measured by a flavour and fragrance company in a sustainable development programme:

- Measurable reduction of energy (water, electricity)
- Measurable reduction of odour emissions
- Improvement of manufacturing processes
- Financial support for charities, aid organisations, and local cultural activities
- Consistent and transparent equal rights and compensation policies throughout the company
- No child labour throughout the company

An important part of such an initiative is the search for sustainable raw materials. There are virtually thousands of different raw materials used in the flavour and fragrance industry. They typically comprise a combination of chemicals, essential oils, extracts, distillates, and others. Many essential oils and other ingredients come from tropical countries and/or parts of the world that are (still) outside of the mainstream business countries, e.g. China, Vietnam, Indonesia, Côte d'Ivoire (cocoa). The supplier companies of these raw materials for the flavour and fragrance industry need to make sure that the supply is sustainable, i.e. specific business practices need to be applied by those companies to maintain and secure the supply. The Chiquita company may serve as a good example in the food industry [11]. Chiquita is by far the most popular banana in the world. The company is number 1 in Europe and number 2 in the USA. The total sales of the Chiquita Company are about US $4 billion. It has been working together for many years with the Rainforest Alliance [12] in order to guarantee the consumers in nine European countries the certified requirements of an independent environmental organisation. The nucleus of these requirements covers social, legal, and ecological conditions that the banana farmers in the respective countries of origin (such as Costa Rica) have to fulfil. Although the Chiquita bananas cost about twice as much as non-certified ones, the concept seems to be being well received by consumers.

One of the important tasks of a marketing department in the flavour and fragrance industry is to study consumer and lifestyle trends to help research and development departments to work on the appropriate long-term projects and the sales force to target the right customers and product categories. In particular, the fragrance and cosmetics part of the flavour and fragrance business is dependent on interpreting these consumer trends ahead of time and correctly.

At the moment the following trends are observable (communication from Symrise's Marketing departmenrs):

1. Consumer segmentation:
   (a) Traditional family continues to alter:
   - Single parent homes
   - Same-sex families
   - Communal living
   - Fewer children
   - Nestlings/"boomerang" kids
   - Longer lifespan
   - Multi-cultural families

   (b) Breakdown in traditional demographic categories:
   - A redefinition of youth:
     - Young—tween, teen, early 20s
     - Super youths—25–39, refuse to get "old"
     - Hip-hops—the new parent, home-owning, trend-setting
     - New seniors—trendier more active
   - A redefinition of all-American: a global population on the move: city to city; country to country

   (c) Shift in ethnicity of USA:
   - Latina population continues to grow (67.5% between 1990 and 2002 vs. 8.1% non-Hispanic)
   - Increasing affluence
   - Very appearance oriented
     - Spend 27% more on cosmetics
     - Spend 43% more on fragrance
     - Spend $1.6 billion annually on personal care

2. Well-being.
   (a) Holistic trend responsible for considerable launch activity:
   - Aromatherapy
   - Aromachology
   - Spa
   - Deng-shui
   - Ayurveda
   - Ki

   (b) Satisfying the consumer's need for feeling restored, rejuvenated, repaired

3. Sensorial branding.
   (a) Products that offer a multisensory experience via:
   - Unique fabrications

- Translucency
- Organic tactility
- Colour infusion
- Light diffusion
- Thermal reaction
- Enticing aromas

(b) Satisfying the consumer's need for feeling stimulated, intoxicated, involved

4. New luxury.
   (a) A quality-of-life approach available to the masses:
   - Masstige
   - Time-sensitive
   - Limited editions
   - Artisan approach

   (b) Satisfying the consumer's need for feeling pampered, special, extraordinary

5. New simplicity.
   (a)Subtle means of self-expression versus bold and blatant branding:
   - Designer labels inside not outside

   (b) Invisible branding/whisper campaigns/viral marketing/underground communication:
   - Flyers, stickers, creating a buzz
   - Street-based promotion
   - Calvin Klein's CRAVE approach to launch

   (c) Satisfying the consumer's need for feeling edgy, unique, "in-the-know"

6. Return to the classics
   (a) Glamour has found its way to centre stage:
   - Tiffany is opening an Iridesse pearl boutique
   - Ladylike designs return to fashion
   - Warmth and character returns to home décor
   - Elegance, grace, style are en vogue

   (b) Move toward:
   - Authenticity
   - Quality
   - Yesteryear

   (c) Satisfying the consumer's need for feeling refined, elegant, glamorous, pampered

But product marketing is getting more and more important for the flavour business as well. Similar to the fragrance side of the business, the early recognition of consumer trends and of course the understanding of the major food and beverage brands is one of the keys for success. At the moment the following ten global trends are observable (communication from Symrise's Marketing departments):

1. Age nullification. Manufacturers need to break away from traditional stereotyping of age groups and explore opportunities of targeting other age groups with their products.
   Food solutions:
   (a) Cool
   (b) Fashionable
   (c) Healthy
   (d) Targeted

2. Gender complexity. Strong cross-over of product usage and behaviour from men to women and vice versa.
   Food solutions:
   (a) Distinguished
   (b) Stylish
   (c) Fashionable
   (d) Personality

3. Life stage complexity. Marketers need to categorise groups by attitudinal and behavioural rather than by traditional demographics.
   Food solutions:
   (a) Convenience
   (b) Small portions
   (c) Meal replacements
   (d) On-line shopping
   (e) Virtual communities

4. Hypertasking. Consumers are becoming more aware of time. It has become an essential part of life.
   Food solutions:
   (a) Convenient
   (b) Bite-size portions
   (c) Accessible
   (d) Easy to use
   (e) Portable
   (f) Back to basics
   (g) Resealable

5. Spending complexity. Understanding the complex mindset of consumers regarding spending money and quality of life.

Food solutions:
(a) Quality
(b) Benefit
(c) Value
(d) Indulgence

6. Health and wellness. Modern consumers are increasingly focused on personal well-being (physical and mental health, beauty).
Food solutions:
(a) Functional
(b) Low and light
(c) Nutritious
(d) Organic
(e) Botanicals
(f) Holistic

7. Sensory sensations. Growing stress, rising affluence, and availability of global foods are driving consumer demands for new and more intense taste sensations.
Food solutions:
(a) Ethnic
(b) Fresh
(c) Gourmet
(d) Novelty
(e) New sensation
(f) Textured
(g) Tryvertising [13]

8. Individualism. Being yourself and having personal needs recognised rather than being part of the mass market.
Food solutions:
(a) Customised
(b) Personalised
(c) Self-expressing
(d) Single-serving
(e) Premium
(f) Trendy and unique
(g) Exclusive

9. Comfort space. Building a secure environment wherever you are is an eminent part of developing a stable and close relationship within your environment.
Food solutions:
(a) Nostalgic
(b) Traditional

(c) Comfort foods
(d) Ethnic

10. Connectivity. Developing a lifestyle that is invigorating and prosperous based on information and opinion as well as life experiences.
Food solutions:
(a) Customised
(b) Personalised
(c) Tryvertising [13]
(d) Health and wellness

Figure 1.2 shows the cuisines of the world with the most potential for growth. In a way, this development is not very different from what is going on in the business and the technology sectors around the world. In a recently published book by Thomas L. Friedman, a phrase was used that describes the world as becoming flat, i.e. growing more and more together [14].

It is interesting to compare the trends on the fragrance and flavour side with each other and see that there are certainly communalities between the two. Figure 1.3 emphasises this point by showing emerging tastes and fragrance trends side by side. In general it is worth mentioning that although the technical elements of the two businesses are very different, i.e. the raw materials used in

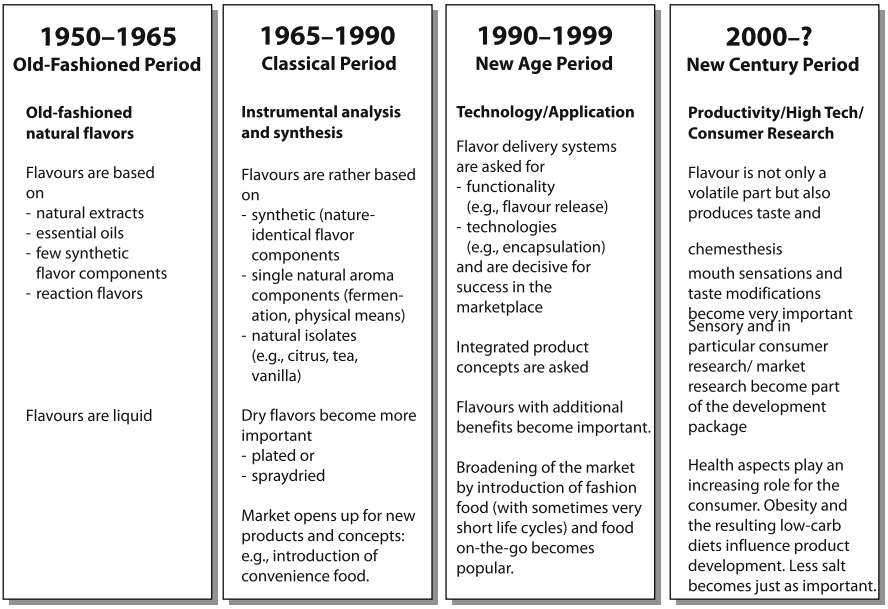

Fig. 1.1 The history of flavour development and taste

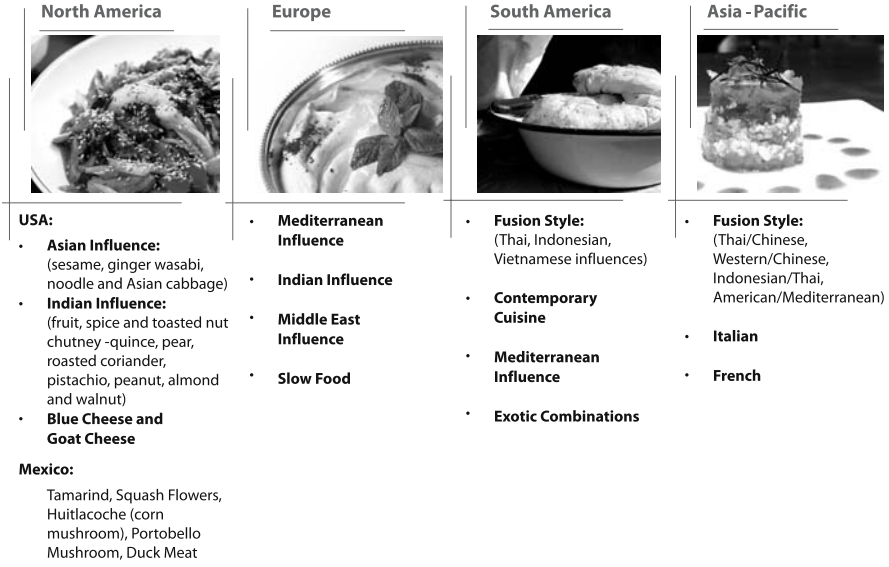

Fig. 1.2 The cuisines with most potential for growth

- **Exotic Infusions**
  - A spicy kick of lemongrass, curcuma, pepper, coriander, ginger, basil, cardamom, cinnamon, oregano
- **Red Pleasures**
  - Strawberry, cranberry, pomegranate, rooibos, greengage, rhubarb, plum, blood orange, cherry variants, black currant, huckleberry
- **Black Health**
  - Black tea, black vinegar, black sesame seeds, black soybeans, black rice, black sugar, malt
- **Botanical Power**
  - Honeysuckle, lavender blossom, elderflower, hibiscus, sunflower blossom, rose

Attracting Opposites
  - Spicy/mild, sweet/sour, hot/cold, fire/ice
- **Ethnic Revival**
  - Traditional tastes & flavors are rediscovered, African hibiscus, Japanese cherry blossom or Maroccan kumquat
- **Flavor Migration**
  - Different categories start to mingle, dessert drinks, coffee cocktails

- **Sophisticated Red Fruit**
  - Pomegranate, redcurrant and raspberry leaves
- **Red Fruit will "go darker"**
  - Blackcurrant, blackberry, black rose and black plum
- **Gourmand notes**
  - Chocolate is big in replacing vanilla as a base, brown sugar
- **Milky notes**
  - milk, milky coconut
- **More specific exotic fruit**
  - Passion fruit, star fruit, kiwi, guava and litchi sorbet instead of pineapple and coconut
- **Pink Pepper**
  - New spicy note
- **Oriental Influences**
  - Tea (red tea and green tea), ginger and bamboo for herbal notes based on oriental influences

Fig. 1.3 Emerging flavours vs. fragrance trends

fragrances are different with a few exceptions, it happens quite frequently that perfumers seek unique bouquet notes on the flavour side. A typical example is the use of fruity notes, in particular tropical fruit notes, over the last few years (communication from marketing departments within Symrise).

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2 Flavours: the Legal Framework

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2.1 Definitions

Flavourings are a major category of ingredients intentionally added to food and feeding stuff. Flavourings are concentrated preparations with the primary purpose to impart flavour except for substances that have an exclusively sweet, sour or salty taste. They are added in small amounts to food or feeding stuff but are not intended to be consumed as such.

Flavourings may contain flavouring substances, flavouring preparations, process flavourings, smoke flavourings and flavouring adjuvants.

Flavouring substances are chemically defined substances with flavouring properties. There are three different categories of flavouring substances defined in the definitions of the IOFI Code of Practice and EU Flavour Directive 88/388/EEC [1, 2]:

1. Natural flavouring substances
2. Nature-identical flavouring substances
3. Artificial flavouring substances

Flavouring preparations are natural complexes used because of their flavouring properties. They contain flavouring constituents and they are obtained by appropriate physical, microbiological or enzymatic processes from foodstuffs or other material of vegetable or animal origin, either in the raw state or after processing for human consumption by traditional food-preparation processes (including drying, torrefaction and fermentation).

Process flavourings means products which are obtained according to good manufacturing practices by heating a mixture of ingredients to a temperature not exceeding 180 °C for a period not exceeding 15 min , the ingredients themselves not necessarily having flavouring properties, and at least one of which contains nitrogen (amino) and another is a reducing sugar.

Smoke flavourings means smoke extracts used in traditional foodstuff smoking processes. The EU Regulation on smoke flavourings subdivides them into four categories:

1. 'Primary smoke condensate' shall refer to the purified water-based part of condensed smoke and shall fall within the definition of 'smoke flavourings'.