The Application of Flavor in Food Processing

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The term flavor has several meanings depending on the context of its use. Here, we may regard flavor as the summation of sensations induced by chemical compounds present in what we eat and drink and in equilibrium at the time of consumption (Hall, 1968; Hall and Merwin, 1981). Some of these flavor components arise from the normal biosynthetic processes of animal and plant metabolism and hence are present in the raw meats, fish, fruits and vegetables which constitute the basic constituents of our normal diet. Other components exist only as precursors and develop characteristic flavoring effects during subsequent cooking or processing due to chemical reactions induced by the effects of heat or fermentation. Some may be intentionally incorporated as flavorings at any stage of the product preparation or used as condiments when the product is served. Whatever the source, the observed odor and flavor impact and quality of the end-product is the total effect of the individual flavoring components which in turn is determined by their relative proportion and their flavor rating.

The flavor in foods may be classified as:

- natural flavor—pre-existing in the diet, particularly in fruits, vegetables, herbs and spices
- process flavor—arising in end-products as a result of conventional processes involving heat or fermentation
- compounded flavor—intentionally added flavorings formulated to produce a desired sensory effect using selected flavorants of natural and/or synthetic origin
- taste modifiers—additives which affect the basic taste sensations (e.g., salt, sugar, food acids and bittering agents)
- abnormal flavors and taints—off-odors and off-flavors arising in products as a result of degradation, adventitious contamination or package/product interaction

The flavor of what we eat and drink is not a static attribute but one which is in dynamic equilibrium, capable of change depending on many factors. In raw materials of both animal and plant origin, it changes during growth and maturation and further during post-mortem or post-harvest handling and preparation for market. Flavors arising from cooking depend on the time/temperature ratio employed in the preparation of the food; the flavor of the freshly prepared product may undergo further modification during subsequent storage. Microbiological growth in products may produce significant flavor changes, some of which are desirable, others detrimental to product acceptability. Flavor changes within the end-product may be due to

- chemical transformation induced by pH, Maillard reaction, hydrolysis, oxidative rancidity, etc.
- volatile losses which upset the relative concentration of aromatic components
- the removal of flavor components by adsorption onto solid surfaces within the product

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- differential partition between aqueous and lipid phases which significantly affects flavor perception

Because there are so many variables, the formulation and production of foods and other consumable products is far from a precise science and depends to a large extent on subjective trial and error to achieve a product profile having maximum consumer acceptance (Heath, 1978). It is well recognised that flavor plays a significant part in product acceptance by inducing hedonic responses and hence consumer satisfaction or dissatisfaction. Poor flavor is a major cause of product rejection (Muskowitz and Chandler, 1978; Blanchfield, 1978).

Achieving Flavor Balance

The control of flavor in an end product is one of profile alteration, which includes

- the selection and balancing of existing or potential factors working within the constraints of nutritional necessity, the nature and sources of the basic raw materials and the total concept of the end product
- the adjustment of the flavor profile resulting from the method of processing employed to suit particular palates or consumer anticipations
- corrections to overcome any pre-existing or developed flavor defects
- the imposition of an entirely new flavor in products which are bland or relatively flavorless

Each of these calls for individual judgment on the part of the product development team and involves the knowledge of available raw materials, optimum processing conditions and probable consumer response to the final product. This is the basis of the culinary art and applies equally to domestic and industrial scale preparation.

The real judge is, of course, the consumer, but in accepting this, one has to appreciate that he or she neither knows nor really cares about the many problems which dictate the use of flavorings; problems such as the form in which the flavoring is to be incorporated, the flavor contributions of its constituent parts, the interaction of flavoring effects within the product or indeed on sensory perception, the problems of compatibility, the complexity of flavor systems necessary to achieve optimum flavor balance, payload protection and satisfactory release characteristics. These and other problems all affect the ultimate flavor profile and determine the success or failure of the product.

It is the correction of flavor defects which poses the greatest problems for the industrial food processor—to maintain a product consistent with consumer satisfaction. The following methods are available for their resolution:

- regulation of the processing conditions as flavor quality is often reduced by excessive heat or agitation
- use of garnishes, sauces and condiments to suit individual palates at the time of eating
- incorporation of flavorings and/or other food additives to achieve either flavor intensification or suppression

Flavor attributes may be intensified by the concentration or addition of a concentrate of the same flavor (e.g., tomato puree added to canned tomatoes); the incorporation of ingredients of a similar or supporting flavor profile to enhance and extend an existing flavor attribute (e.g., use of almond essence in cherry pie filling); the addition of flavorings as topping notes to replace those lost during processing (e.g., coffee aroma added to instant coffee); and the judicious use of flavor potentiators (e.g., M.S.G, ribonucleotides, maltol).

Flavor attributes may be suppressed by removal of the unwanted character by further processing or maturation; incorporation of adsorbent materials (e.g., starch); neutralisation or conversion of the flavor impact by adjustment of pH or of the salt/sweet/acid balance; dilution with non-flavorful ingredients; masking or disguising the flavor by using stronger flavorings (e.g., use of seasonings in meat products). The most appropriate technique to use may have to be established by trial and error and even then may only be partially successful.

Criteria for Application of Flavorings

Flavorings may be added to food and other consumable products for various reasons, but mainly

- to impart flavor to an otherwise bland product. The flavoring may be in imitation of an existing natural flavor or may be created to give some desirable flavor experience
- to impose a different flavor character from that arising from the basic ingredients
- to boost weak intrinsic flavors or replace flavor notes lost during processing
- to modify or complement an existing flavor profile

- to disguise or cover undesirable flavor attributes
- to overcome seasonal variability in natural flavoring materials or constituents
- to impart a flavor where the use of a natural flavoring material is technologically impracticable
- to make available at an economic price the flavor of materials which are of limited availability or are unacceptably expensive
- to make available flavor types where the natural product poses toxic or other hazards

One of the major functions of intentionally added flavorings is to extend the range and flexibility of food products and processing technology, but their specific application is determined by factors which are not exclusively technical in character. These include:

Acceptability to the consumer—the flavor of food, drinks, confectionery, and snacks is open to wide hedonic interpretation. Preferences display a broad spectrum depending on such factors as ethnic origins, education and upbringing, age, environment, and even one's personal mood at the time. The strength and quality of flavors are often regionalised. This poses a big problem to the manufacturer aiming at national or even international distribution. Indeed, this desire to please everybody often results in less than top quality products aimed at minimum rejection over a wide market area than maximum acceptance in a smaller region.

Legal acceptability—this is of increasing concern to the food manufacturer and in most developed countries, the use of flavorings is controlled by legislation aimed at safeguarding the consumer from real or supposed health hazards arising from the ingestion of materials intentionally added to the natural diet. A secondary aim is the prevention of deception as to the true nature of the products which the consumer must take on trust. It is essential that any product complies with the legislation of the country in which it is offered for sale to the consumer and ignorance of the law is no defence.

The nature of the product as sold and its subsequent preparation for consumption—today the range of consumable products is enormous resulting from a rapidly advancing processing technology, imaginative product conception, versatile packaging and efficient distribution. The form of the product will determine the form in which flavorings may be incorporated but this

is the subject of a separate contribution. It is sufficient here to say that dry goods call for powdered flavorings and wet goods enable one to use flavorings in liquid form. In deciding the most appropriate flavoring, the product development team must be able to produce a facsimile of the end product under laboratory or pilot plant conditions closely similar to those encountered in full scale production. This is the only sure way of establishing the technological and aesthetic acceptability of a flavoring in the finished product. Evaluation of flavorings in alternative media may be adequate as a first-stage screening but may be quite misleading in relation to the final product.

Many products require further preparation and cooking by the consumer. Here, one generally has little or no control. Preparation instructions must be simple and precise but even so, some allowance should be made for indifferent domestic handling. It may be desirable to set flavoring levels a little high as excessive cooking, the usual problem, can seriously reduce flavor content to the detriment of product acceptance.

Processing conditions—these are of major importance and worthy of detailed consideration (see below).

Each of these areas of constraint is complex and makes very special demands on the flavor industry in its service to food processors. Individual flavoring compositions must reflect public tastes and indeed prejudices, as well as catering to unpredictable and often short-lived demands, particularly in the fields of snacks, confectionery and ice cream. Flavorings must be compatible with other prime constituents in the end product, be resistant to processing conditions, and be stable before, during and after incorporation into the finished product.

Very few flavorings are suitable for all applications as processing conditions as well as the physical character of the end product often pose unique problems in flavoring incorporation and subsequent flavor stability. Few generalisations are possible in such a diverse field and I propose, therefore, first to consider the processing constraints and then to review products by groups in which the processing conditions are broadly similar. By this means I can highlight the problems and indicate the methods currently used for achieving satisfactory flavor application, although I am sure the reader will appreciate that each product group is capable of in-depth treatment outside the scope of this paper.

Processing Operations

Unit operations encountered in the processing of foods, beverages, confectionery and other consumable products are relatively few. These are mainly associated with raw material preparation, mixing and blending, thermal processing involved in various methods of cooking, the retorting of cans or pouches, refrigeration, dehydration, irradiation and packaging. Within these processes the following conditions are the most important determinants likely to affect the incorporation of flavoring materials and the flavor profile of the end product.

Temperature and time—by their aromatic nature most flavoring materials are to some extent thermolabile. At elevated temperatures, particularly in the presence of water, they may be lost to the system through evaporation or steam distillation. Less stable compounds may change due to chemical interactions with other constituents. The degree of change is usually a function of both temperature and time. The effects of ultra-high temperatures for short time intervals may result in less flavor degradation than occurs with much lower temperatures employed over a longer period, although this will depend on other factors internal to the product (e.g., pH or presence of proteins). A knowledge of the temperatures to which the total flavoring system will be exposed and the dwell-times involved is most important in deciding the nature of the flavoring to be used, particularly in respect of any solvents present, in systems in excess of their boiling points. It should be remembered that large bulks often retain their heat disproportionately to small quantities and this too may have a deleterious effect on the flavor profile.

The effects of heat processing are most obvious in products containing both sugars and amino acids as these are susceptible to non-enzymatic browning. Also those containing high levels of lipids become prone to oxidative rancidity which generally results in quite unacceptable off-flavor notes.

Open or closed system—the incorporation of flavoring materials in an open system (i.e., blending in an open vat) is likely to result in greater volatile losses than in a closed system (i.e., in-line processing or retorting in sealed containers). Where open handling cannot be avoided, every precaution should be taken to minimise exposure by using covered containers and avoiding exposure to direct heat. The bigger the unit bulks and the higher the temperatures

employed the greater the chances of flavor loss or degradation.

The mixing sequence—the guiding principle is to expose any added flavoring to the minimum of treatment. Obviously, in some products addition into the primary mix cannot be avoided, but wherever possible flavoring should be added at as late a stage consistent with uniformity in the end product.

pH—most fruits contain natural acids which contribute significantly to the flavor profile. The use of added acidulants is necessary when one is employing an imitation fruit flavoring which is intrinsically neutral; otherwise the correct flavor impression is not achieved in the end product. Some flavorings contain ingredients which are sensitive to changes in pH and it is essential that this particular condition be carefully reproduced during the product development stage and during subsequent shelf-life testing.

Pressure—both positive and negative pressure changes are likely to endanger added flavorings by altering the relative concentration of aromatic components in the headspace. Vacuum filling may result in more volatile components being preferentially lost to the system resulting in an unbalanced profile in the end product.

Contact with air—this is of particular concern in products which are aerated (e.g., ice cream, marshmallow). High-speed mixing operations can result in considerable volatile losses, but, more importantly, any occluded air produces conditions conducive to oxidation of contained lipids. The pneumatic conveyance of powdered products containing flavorings (e.g., soup mixes, instant puddings and dessert powder, or sauce mixes) may also result in significant volatile losses unless encapsulated flavorings are used. A similar consideration applies to flavorful products predispensed into vending machine containers.

Specific Flavor Applications

In order to give you some practical indications as to how these generalisations affect specific product groups I intend to review briefly the processing of meat, baked goods, snack products, sugar confectionery, pickles and sauces, soups, frozen goods and soft drinks. This covers an enormous field of processing technology particularly when one appreciates that there are many sub-groups calling for individual consideration. The details of flavor application in each case must be left for the specialist.

Meat Products

This group of products embraces all types of meat, meat by-products, poultry and fish. Although large quantities are sold for domestic preparation it is that which is industrially processed which is of most concern to us. The resulting products include fresh, semi-dried, dried, fermented, deep-frozen and canned meats which may be eaten directly either cold or after reheating or after some further domestic preparation. The opportunities for using added flavorings are almost limitless but the diversity of product types, many of which are now traditional, imposes considerable constraints on the nature of any added seasoning or flavoring materials.

In savoury foods, the prime taste adjunct is salt and its level is significant in the total flavor profile. Additional flavoring effects may be achieved by using blends of herbs and spices together with flavor enhancers, hydrolysed vegetable protein or yeast extracts where these are permitted.

The basic technology of meat processing is complex and often specific to the manufacturer and the individual product line. Whatever the

process, the following factors must be taken into account when selecting an appropriate seasoning:

- nature of the raw materials used, particularly the lean/fat/water ratio
- the nature of any pre-treatment, particularly the use of curing agents
- the stage and method of incorporating the seasoning
- the degree and nature of any comminution stage
- post-mixing treatment particularly involving heat (i.e., cooking, smoking, drying or retorting)
- the temperature and times involved at any stage particularly in an open system
- the nature of any added preservatives, particularly SO_2
- methods of packaging, particularly vacuum
- post-packing handling and storage, particularly refrigeration

This, you will appreciate, implies a precise knowledge of the product and its method of preparation and in this one cannot generalise.

The principal aim of incorporating seasonings into meat products is to impose added flavoring notes which will enhance the natural meat flavors present; maybe modifying them to suit individual palates but not swamping them. Traditionally, seasonings for meat products have been prepared from ground herbs and spices. Numerous articles have appeared in the technical literature discussing their advantages and disadvantages.

Increasingly, the industry has adopted seasonings based on spice extractives (i.e., essential oils and/or oleoresins) dispersed on edible carriers to give a standardised flavoring effect. Such seasonings are generally in the form of dry powders comprising not only the appropriate herbs and spices but also other permitted additives. These may include flavor enhancers, hydrolysed vegetable protein, yeast extracts, salt, phosphates and colorants. They are frequently supplied pre-blended in unit packs to facilitate addition to a single processing bulk at the chopping stage.

With an increase in automated processing with controlled dosing of ingredients, the use of seasonings in the form of liquid emulsions is gaining in popularity. These have all the advantages of the dry seasoning but can be accurately metered and rapidly dispersed into the chopped meat matrix. They are more concentrated than powdered seasonings and many are designed for use at 2g per kilogramme meat mix.

The processing of poultry and fish calls for a specialist technology and time does not permit its further consideration.

Baked Goods and Bakery Products

This important branch of the food industry embraces such products as bread and rolls, sweet yeast dough products, biscuits, cookies and crackers, pies and pastries, cakes and breakfast cereals. All of these are based on flour mixed as necessary with sugar, eggs, milk, shortenings, leavening agents or yeast and flavorings. The industry covers an enormous range of specialist products many of which involve purpose-designed plant and processing techniques. The following constraints will determine the choice of the flavoring

- the effects of temperature and time
- flavor balance, particularly acidity and sweetness
- stability on storage, particularly related to
- moisture content of the end product

Within this product group flavorings may be incorporated in one of four ways

- mixing into the dough prior to baking
- spraying onto the surface of the product as it emerges from the oven
- dusting on to the surface after oiling
- applying as a cream filling, glaze or coating

Of these, baked-in flavors pose the greatest problems both of volatile losses and flavor change. In practice, it is found that the use of fat or oil-based flavors reduces losses. With liquid flavorings it is advisable to use a solvent such as propylene glycol (where this is permitted) and to pre-mix the flavoring with any fat present in the product. Heat resistant powder flavors made by multi-stage encapsulation are commercially available and these are very effective but a little costly in application.

Snack Foods

Snack foods include both potato chips and extruded products based on various farinaceous materials. In the case of chips, flavoring is limited to surface dressing or dusting and many specialist flavors such as "salt and vinegar" and "barbeque" are widely popular. Chips made from reconstituted potato starch offer a great opportunity for including the flavor in the dough prior to cooking (Blake and Renwick, 1978).

Extruded products pose additional problems and flavoring is accomplished in two ways

- flavoring incorporated into the dough or pre-mix prior to extrusion, which will be influenced by whether it is hot or cold extrusion, and
- external flavorings incorporated by dusting or coating

Cold extruded products such as pasta are best flavored by using emulsions added to the system with the formula water although pre-blending of a spray-dried flavor with the flour portion is also quite acceptable.

Hot extrusion is used for an increasing range of snack products, breakfast cereals and pet foods, based on corn, oat or wheat flours with appropriate additives and water. The conditions are very severe as in most extruders the mix is exposed to high pressure (500-900psi) and very high temperatures (120-176°C or even higher) followed by a rapid steam flash-off as the product expands on leaving the extruder. It is necessary for the product then to be dried to about 8% residual moisture. Such conditions cause evaporation of a significant percentage of flavor volatiles and impose a severe constraint on the type of flavoring to be used (Lyon, 1980; Van Polen, 1980). Acceptability is generally one of trial and error under the exact processing conditions envisaged. In the case of thermal reaction flavors (e.g., meat) based on sugars and amino acids, the precursors may be added to the pre-mix and allowed to react during the extrusion.

The extrusion manufacture of meat analogues based on soy flour poses quite different problems for here it is essential that no residual soy flavor remains in the end product (Ritter, 1978).

The application of surface dustings is very widely used but the method is not without its problems. Savoury flavors, particularly those containing hydrolysed vegetable protein, yeast extract, cheese and onion powders are frequently hydroscopic, tending to cake and become sticky. This leads to uneven distribution and a blocking of the application machinery. From a consumer point of view, surface-applied flavors are only satisfactory where the base product is acceptably flavorful and far less so when the product is flavorless as in the case of most extruded snacks.

The use of residual surface oil or oil sprays poses limitations, not only on the nature of the dusting but on the shelf life of the product as rancidity readily sets in unless the products are given a limited shelf life. Electrostatic applicators are now proving to be a more acceptable alternative method.

Sugar and Chocolate Confectionery

The processing constraints which determine the most suitable flavorings for use in sugar confectionery are so diverse that each warrants separate consideration (Weekes, 1978). The main sectors involved are

- high-boiled confectionery (i.e., hard candy)
- low-boiled confectionery (i.e., chewy caramels)
- starch-deposited confectionery (i.e., pastilles)
- chewing gum
- chocolate

Unfortunately, it is quite impossible to examine each of these in sufficient detail. However, the list of available flavorings is comprehensive and most flavor manufacturers readily supply usage data applicable to the various product groups concerned. Some flavorings on their own are quite flat and lifeless even when they have an impressive aroma. Fruit flavors generally need the support of citric, tartaric, malic or lactic acids in amounts varying between 0.25% and 3% depending upon the end product.

In confectionery products where added flavor is paramount, choice is critical and one must try for the most natural. Using flavor in unusual combinations is rarely successful.

In modern confectionery manufacture, continuous and automated processing is replacing the older batch methods and this imposes special constraints. In most plants, the flavoring is injected into the cooked sugar mass as it moves through the system hence mixing time is very limited and for uniform flavor effect ease of dispersion is critical. Flavors must withstand 154°C but long dwell-periods at 140°C are not uncommon and these can induce undesirable profile changes. The need to use vacuum for deaeration also leads to flavor loss and it is usual to add up to 25% more flavoring than would be necessary in batch processing in order to achieve the same sensory impact.

Chocolate manufacture is very much something for the specialist but even here added flavorings can be of value

- to modify the flavor of the basic chocolate mass (e.g., the use of vanilla extract, vanillin, or ethyl vanillin) to give a rounded smoothness to the profile
- to impose an over-riding but compatible flavor (e.g., orange, rum, peppermint)
- as a flavoring for fondant-based or other centres

Pickles and Sauces

This group of products is characterised by their high content of acetic acid and the use of herbs and spices to achieve the desired flavor profile. Variety of end products is obvious, the main quality attribute being the correct balance between piquancy, spiciness, acidity, saltiness, sweetness and fruity character to provide the appropriate flavor adjunct to the dishes with which they are to be eaten. The group embraces

- thick sauces (e.g., fruit sauces, prepared mustard, salad creams and dressings, mayonnaise, tomato ketchup)
- thin sauces (e.g., Worcestershire)
- thick pickles (e.g., mustard, relish and chutney)
- clear pickles (e.g., single vegetables, sweet mixed pickles)

The processing technology involved is specific to each product sub-group hence one cannot reliably generalise on flavor usage. However, in broad terms, it is the judicious use of herbs and spices coupled with the correct degree of acidity which largely determines the acceptability of the end product. In developing a suitable flavoring system two factors are determinants: the extent to which the flavor should complement or override the predominant flavor of the base and the necessity for the flavoring to be completely soluble in the liquid phase. Processed spices, in the form of oleoresins and/or essential oils, are widely used for this purpose in the form of solubilised flavorings in an acceptable solvent or as an emulsion. These can readily be solubilised by a mixture with a polysorbate (e.g., Tween 80) but the use of these is restricted by legislation in many countries. Other methods of dispersion generally give a pickling liquor which is more or less cloudy calling for filtration prior to use.

Soups

This form of nutriment is probably the most widely used worldwide for almost anything that can be eaten can be used in making a soup. Apart from those prepared domestically from fresh ingredients, manufactured soups occur in one of three forms: canned, either single strength or concentrated; dry mix for reconstitution as required with or without additional cooking; and frozen. Each of these calls for a different approach for flavoring designed to maintain consistency in the end product.

In the manufacture of canned soups, concen-

trates and quick frozen soups, the end product is liquid and hence it is advantageous to use liquid flavorings although dispersed spices blended with other dry ingredients are quite satisfactory. In automated processing, a total liquid flavoring system is advantageous as this allows metered dosing and very ready dispersion throughout the bulk.

Dehydrated soups require the use of dry powder flavorings and seasonings, but the question of seasoning blends and the flavor profile of the end product are matters of opinion depending on the raw materials, consumer expectations and price. Dispersed or plated spice products are adequately stable when the product is packed in sealed laminated sachets but, wherever possible, flavoring products in which the aromatic fraction has been encapsulated should be selected to ensure maximum shelf life. It should, however, be remembered that such products do not have any intrinsic smell. Most flavor manufacturers offer a wide range of such products. Encapsulated flavorings are of particular value in soup powder mixes formulated for automated vending in pre-dosed containers as the aromatics are not only liable to be lost from the product but may also contaminate other products within the machine.

Ice Cream and Frozen Goods

The choice for flavorings for ice cream, sherbet, and water-ices is wide and their selection depends on the quality of the end product and on regional and age preferences. The flavoring of products intended to be distributed under chilled or deep freeze conditions calls for careful attention to application techniques and the use of flavorings purpose-designed for these types of products. The following are determinants.

- accuracy of dosage to achieve flavor consistency
- economics, as flavorings contribute significantly to product quality in these product types
- dispersion in the product mix
- the percentage of lipids present in the product
- hygiene, as flavors are added after pasteurization they must be microbiologically acceptable

It must be remembered that these products are eaten cold and that this has a marked impact on flavor perception due to "freeze-out" and resultant fading of flavor impact (Grabb *et al.*,

1979). There is an enormous range of flavorings available for use in ice cream, including naturals such as cocoa powder, fruit pastes, natural extracts and essences, particularly vanilla, and imitation flavorings. The profiles of these are legion and synthetic chemicals such as vanillin and ethyl vanillin together with ingredients like fruit pieces, nuts, or crystallized fruits are widely used.

When checking the usage level of any flavoring material it is essential to establish the degree of overrun which for ice cream is generally 70-80% but in water-ices may be as low as 25%. This obviously will have considerable impact on the flavor level in the end product.

Soft Drinks

This product group includes carbonated beverages, both clear and cloudy; non-carbonated drinks such as squash and cordials usually concentrated and requiring dilution by the consumer; specialties such as ginger beer, the various cola products and root beer; and "crystal" beverages which are in powder form requiring reconstitution with water (Downer, 1973; Ratcliffe, 1978). Flavorings for use in such products must

- impart the characteristic profile implied by the name
- be technologically compatible
- be stable to heat, light, acids and preservatives, particularly SO_2
- impart the correct physical appearance to the product
- be free from spoilage organisms
- be legislatively acceptable

Their application is, of course, dictated by the required appearance of the end product and as many flavoring materials are either insoluble or only sparingly soluble in water, techniques have been developed for their incorporation. Two methods are widely used

- they can be dissolved in a permitted solvent so that when added to the concentrated bottling syrup and ultimately diluted they remain in solution or
- they may be emulsified. Emulsion flavors are generally used to produce a cloud in a drink which would otherwise be clear.

Crystal beverages offer few problems. These products fall into two broad categories: high quality products made from spray-dried fruits, and cheaper lower quality products based on imitation flavorings. A wide range of dry powered flavorings are available.

Conclusion

As the reader will readily appreciate, I have probably omitted more about flavor application technology than I have covered but this is inevitable in a presentation such as this. Each product group poses its own specific problems to a point where generalisations are of limited value.

Within each segment of the food and related industries there are technologists whose responsibility it is to ensure that the end products are correctly flavored to satisfy customer expectations, technological needs and legal requirements. To parallel this, the flavor industry itself employs technical service experts to give advice on flavoring choice and applications. It is the close collaboration between flavor manufacture and the user industries which ensures the present high standards of our manufactured food products and ensures that flavorings are used under optimum conditions. Remember that the better the communication between development technologist and creative flavorist the better the chances of success for the end product; and that is what everybody wants.

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