Flavoring materials are among the most complex components of modern food products; they are made from a large number and variety of ingredients from different sources. The complexity of flavoring materials makes them particularly interesting with regard to regulatory compliance and other requirements, such as halal status. It is important to note that more than 90% of raw materials used in the manufacture of flavors pose no risk whatsoever to the halal status of the finished products because their
origin is either synthetic or from acceptable plant sources. This is a welcome simplification, as there are over 4000 ingredients in general use in the flavors industry, and most suppliers of these raw materials provide no halal certification (Uhl, 2000).

In most markets, the terms “flavors” or “flavoring” can include many materials as long as they collectively act to alter the sensory perception of the finished food product as perceived in the mouth and nasopharynx, with the exception of altering the basic tastes of sweet, salty, sour, bitter, or umami. Thus, an additive whose purpose may be to lower sugar content by boosting the perception of sweetness may be used and declared as a flavoring material only in concentrations that do not by themselves taste sweet. At levels above the threshold at which sweetness is observed from the material by itself, it must be declared as a food additive or sweetener. As another example, citric acid is used as an acidulant (without which many fruit flavors would taste flat or cloying) in soft drinks and must be declared as such, as at almost any effective level, the material by itself will impart a sour taste. It cannot therefore be represented in ingredient statements under the generic category of “flavor” because by itself it alters one of the five basic taste modalities. Some ingredients in flavors have more than one function and it may be left to the discretion of the manufacturer whether to declare them under the category of “flavors” or as individual additives (U.S. FDA, 2016).

The complexity inherent in flavoring preparations has led to the acceptance of a wide range of materials under the broad category of “flavors,” especially for the purposes of consumer labeling. Although the reasons for this are pragmatic (consider the effects of listing an additional 20 or more ingredients—which the flavor manufacturer wants to keep confidential even from the food companies they serve—on every food label), the practice can raise questions about flavorings as places where undeclared additives of unknown or dubious origin may be introduced into food products. To address these concerns, most regulatory organizations such as the European Council and the U.S. Food and Drug Administration (FDA) have succinct definitions that determine what may or may not be included under the term “flavor”: U.S.: 21 CFR 501.22, 21 CFR 101.22; EU: EC 2334/2008; and so on. The halal status and related characteristics of non-flavoring food additives are covered in other chapters of this book; the following pages will therefore treat several classes of flavor products and those raw materials commonly declared as flavors or flavoring, in addition to some important intermediates used in their manufacture.

Flavor products are available in a wide variety of different forms, from simple mixtures compounded from a few liquid ingredients to highly engineered “flavor systems” that may include sophisticated encapsulation technology. The form taken by any particular flavoring material is dictated by several factors but is heavily influenced by the nature of the application (a carbonated soft drink and a breakfast cereal, for instance, can have vastly different requirements, including solubility and dissolution, heat stability, and compatibility with other food ingredients, to name only a few). Shelf-life, ease of handling, and cost in use are other factors that may determine the form in which a flavoring product is distributed and used.

Halal food producers and consumers benefit greatly from the information flavor manufacturers collect to meet product quality and regulatory requirements. Raw materials used in the manufacture of flavors must be scrutinized closely for
assurance that the producer maintains the ability to consistently make and appropriately market and label their products. To supply a product that meets customer requirements for natural or organic status, for example, information must be maintained on each raw material in the product’s formula, as a single synthetic ingredient or sufficient quantity of uncertified components can affect the status of the finished goods. The need to identify and track such diverse information on every raw material allows the tracking of the halal status of any individual ingredient to be integrated as a routine process.

How then does one begin to evaluate the halal status of products containing dozens of ingredients (from a palette of literally thousands)? The answer is to focus closely on those materials that pose the highest risk. Halal rules for flavorings can be generalized to four principles, with some minor exceptions:

1. Animal products must be halal either intrinsically (honey, dairy products) or from acceptable species slaughtered according to Islamic law. Vegetable materials are halal except if modified to include genetic material from animal sources.
2. Ethanol and other intoxicants are not halal. Some allowances must be made for ethanol that occurs naturally or in proportions that cannot result in intoxication, but products derived from the manufacture of alcoholic beverages are forbidden.
3. Fermentation agents including microbes and enzymes must be derived and maintained according to halal principles—that is, origin and genetic modification should be monitored, and growth media must be free of non-halal ingredients or additives.
4. Production equipment and environments must be managed to preclude any possibility of contamination of halal products with haram materials.

The first three of these requirements can be adequately managed through control of sourcing and formulation information. Collecting data from suppliers about ingredient origin, halal certification, and other aspects, such as specifics of genetic modification or manufacturing details, will allow the automatic screening of product formulas for non-compliant ingredients as described previously. Monitoring of production environments usually requires the establishment and enforcement of manufacturing procedures to ensure the integrity of halal flavors. This will be discussed in depth later in this chapter.

A final corollary to these principles is that any gray area or question arising in relation to the halal status of ingredients or finished products can only be resolved through the decision of a competent halal authority.

An unavoidable characteristic of the global business of food production is that certification authorities will have differing standards and approaches to halal manufacturing. Successful outcomes are the product of excellent relationships with certifying bodies as well as a fundamental commitment to maintaining the integrity of halal programs, including policies governing the entire value chain from raw material purchasing and formula creation to the management of inventory, production, and shipping processes.
It is entirely fitting, even intuitive, that food should hold a central place in most cultures, and that those who provide such necessities to the general population are held to high standards of integrity. This is reflected in the detailed legislation dealing with food and its production in most parts of the world; it is also reflected in the suspicion with which corporations and other profit-driven entities are sometimes regarded with respect to providing products for consumption. These circumstances combine to represent a significant risk to businesses engaged in the production of food and food ingredients. Inasmuch as halal production is undertaken to provide opportunities to access markets that would otherwise be closed (i.e., a commercial motivation), the costs and sacrifices in flexibility involved must be fully understood. A lapse in commitment or procedure in the manufacture of halal products may naturally lead to questions of compliance in other areas, and by itself can be sufficient to severely damage a brand. If the necessary resources and attention to program design and maintenance cannot be met, it is far wiser to forego business opportunities in the halal sphere than risk noncompliance. The information that follows has been accumulated over many years of managing the halal aspects of flavor manufacturing in many different contexts and circumstances.

**SIMPLE MIXTURES**

**CONCENTRATED LIQUID FLAVORS**

Perhaps the most common form flavoring materials take is that of concentrated liquids. The reasons for this are many, including greatly simplified handling and manufacturing, ready availability of raw materials in liquid form, general (though not universal) lack of solubility problems, and the more practical commercial advantages related to shipping and cost in use. The halal status of liquid flavoring materials, as that of all other flavor preparations, depends not only on the status of the raw materials used in the formulations, but also on other aspects peripheral to the ingredients themselves, and specifically on the production equipment used to manufacture, handle, and store them. The primary simplifying characteristic of liquid flavors with respect to halal is that the manufacturing formula can be used to determine the status of the raw materials in a straightforward way. That is, in most cases the finished product is a simple mixture of ingredients, and there are usually very limited circumstances (covered below) in which interactions between the raw materials can affect the halal status. Additionally, a liquid flavor formula that has been certified as halal can itself be used as a component of any number of flavoring materials (of almost any form), and its halal status can be verified by certificate instead of scrutinizing each raw material in its formula.

**DILUTIONS**

Diluted liquid flavors provide a case to illustrate the value of certifying concentrated flavoring materials. To establish the halal status of a dilution, one need only to provide the certificate for the concentrated form and assure that the dilution solvent is
acceptable for use in halal products at the level considered appropriate by the certifying authority. The obvious complicating case is the use of ethanol as a dilution solvent (covered in more detail below), but there are other solvents in common use that can be derived from or adulterated with non-halal materials. Glycerin is a commonly cited example of a diluent that can be sourced from animal fats, although the synthetic version and even natural versions from vegetable sources are more widely available and less expensive. Again, careful attention to the collection and validation of information from raw material and solvent suppliers is critical to assuring the integrity of halal formulations.

PROCESSED FLAVORING MATERIALS

In contrast to simple mixtures, flavoring materials that undergo additional processing steps cannot necessarily be considered as mere combinations of the raw materials in their formulas.

EXTRACTION

Extraction is a widely used technique that selectively removes specific active or desirable flavoring components from more complex (usually a natural product) matrices by processing the starting material with a solvent. The key considerations for halal are the makeup and halal status of the base matrix as well as the extraction solvent. Common examples include:

1. **Natural extracts**: This process involves the removal of active flavor compounds from the biological matrix in which they naturally occur. This can be accomplished with a variety of solvents, although the manufacture of extracts for use in food (and flavoring) is limited to those with acceptable toxicity including water, carbon dioxide, and ethanol, among others. Natural vanilla extract has a specific standard of identity maintained by the U.S. FDA and must contain a minimum of 35% ethanol to meet the standard: U.S. FDA, 21CFR169.175. Halal certification authorities manage this requirement carefully, requiring information about the source of ethanol in the extract and verifying a level of use that will bring the alcohol content in consumer goods to an acceptable level before allowing the extract to be used in a product labeled as halal. The extract itself cannot be certified or labeled halal due to the high level of ethanol.

2. **Washed oils**: These are water and alcohol extractions of moderately polar flavor compounds from essential oils, which were in turn removed from their source via pressing (usually the case for citrus) or distillation and concentration to a homogenous oil phase. This technique uses water adjusted with some type of alcohol to provide an extraction solvent with the appropriate polarity. The solvent is combined with the essential oil (with which it is not miscible) and agitated to extract the desired polar compounds. The solvent is then decanted and may be filtered or standardized in subsequent
steps. The resulting product has the advantages of water solubility and relatively high concentrations of many of the most intense flavor compounds present in the original essential oil. If ethanol is used in the extraction solvent, specific information about the source and level will be considered by halal certifying bodies before allowing these extracts to be used in their halal foods.

**REACTION FLAVORS**

Flavoring preparations that specifically rely on chemical reactions between two or more raw materials to provide the desired flavor characteristics represent another level of complexity, as the composition of the finished product is quite intentionally different from any of the starting materials. However, the key to evaluating halal acceptability of these products again lies in examining their formulas. Two examples of this category of flavoring preparation bear special mention:

1. **Maillard reactions**: This term describes a complex chain of events, the details of which are beyond the scope of this chapter, except to mention that the first reaction step is between an amino acid and a reducing sugar molecule. In the context of halal acceptability, the focus will be on the source of the amino acids used in the reaction in addition to the other ingredients in the formula. It should be noted that although Maillard reactions can often be used to generate “savory” or “meaty” flavors, the tonality of the finished product does not necessarily provide an appropriate assessment of halal risk. Amino acids derived from animal sources can be involved in the creation of vegetable, cereal, or bakery flavors, and likewise many “meat” flavors can be created with amino acids strictly from vegetable sources. For a comprehensive treatment of this subject, see Nursten (2005).

2. **Esterification**: This reaction involves the creation of an ester compound by the controlled reaction of an organic acid with an alcohol. Esters occur naturally in many foods. Characteristically fruity and ethereal, they are commonly used in the manufacture of food flavors. The reaction itself occurs in aqueous solutions and can involve almost any alcohol-acid combination; it is enhanced with the proper control of pH and heat. Again, the primary concern for halal will be the source of ethanol if it is used as the alcohol in the reaction. Esters of ethanol are recognized by the word “Ethyl” at the beginning of the compound name (e.g., ethyl butyrate or ethyl propionate, denoting the combination of ethanol with butyric and propionic acids, respectively). Esters formed from other alcohols pose no risk for halal. It must be noted that the esterification reaction is reversible, and in the proper conditions, esters, including ethyl esters, can revert to their constituent alcohol and acid. It is therefore possible for a product that contains no ethyl alcohol from its formula to have small but measurable amounts of ethanol through this process. The concentrations of ethanol seen in these cases will rarely rise to a level of concern for halal.
ENGINEERED FLAVOR “SYSTEMS”

To meet specific needs of food producers and consumers, flavor manufacturers respond with innovation and new applications of technology. Whether the challenge is extending shelf-life, providing temperature stability for cooking or baking applications, or solving solubility problems, flavor producers routinely reach beyond the confines of flavor chemistry to address the evolving needs of their clients and global markets. The results of these efforts often take the form of products that perform some functional role in consumer goods in addition to delivering flavor. In assessing these materials for halal suitability, novel or unusual ingredients may be encountered that require special consideration. As the functionality of flavor systems may depend on unique raw materials that impart the functional properties desired, attention to these ingredients is a common principle across all technology platforms. Often, complex and expensive production equipment is required to manufacture these functional flavor products, and strict segregation policies should be followed to avoid inadvertent contamination of halal-dedicated machinery.

Spray-Dried Flavors

Spray-drying is a mature technology used to dry liquid flavor materials to give a solid matrix, and the final product is a powder that may have a range of physical properties that largely depends on the nature of the matrix and particle size. Spray-drying equipment usually represents a large investment, and the drive to utilize capacity may lead manufacturers to run non-halal formulas on the same equipment that is used for halal production. Generally, this does not present a problem when operational procedures include appropriate cleaning steps in between products (as determined by the halal certifier); although, in most cases, the manufacturer’s internal quality requirements are more than adequate to address halal concerns. The notable exception is the use of any materials of porcine origin; even carefully validated cleaning procedures are not sufficient to maintain halal acceptability for equipment that has been used to process pork or its derivatives. In the event of accidental contamination, the halal certifier may recommend some extraordinary measures to rehabilitate the equipment; however, extensive downtime and expense should be expected. Careful production planning and close consultation with certification authorities should minimize this eventuality. A toll-manufacturing strategy can be effectively applied when options for drying non-halal or pork products are limited. If non-halal-slaughtered beef gelatin were to be dried in a spray-drier—cleaning of spray-drier going to be impossible—the drier needs to be dedicated. Manufacturers are increasingly turning to external contract spray-drying operations to manage complex production issues, and many of these contract dryers have robust halal programs in place.

Emulsions

Emulsions are another time-tested technology used to achieve desired solubility properties, especially in beverages. High-shear mixing of aqueous and oil phases is used to achieve the complete suspension of small particles of one of
the phases in the other. Stability—or rather, instability—of emulsions is a thermodynamic phenomenon and can be modified by the use of materials that act at the surfaces of the microscopic particles within the emulsion but it never can be fully stable. Many common emulsifiers such as esters of sorbitan (polysorbates) or glycerin (mono- and di-Glycerides) function because their molecular structure facilitates “bridging” aqueous and oil phases—a polar section of the molecule interacts well with the aqueous phase, and a lipophilic portion associates with the oil phase. These materials may be sourced partly or entirely from animals and appropriate validation of the origin of these or other surfactants and emulsion stabilization agents is needed for halal certification of products in which they are used.

**OTHER ENCAPSULATION TECHNIQUES AND FLAVOR DELIVERY SYSTEMS**

This subject is very dynamic given the rapid evolution of products for consumer use, which drives innovation in flavor technology. The principle concerns are the use of new ingredients that impart novel properties to the product, and any specific processing equipment or steps. Manufacturing equipment will not in itself pose a risk to the halal status unless it can be contaminated by najis (mainly pork) materials. Concerns related to ingredients in the area of innovation in flavor systems can be extended to the use of biotechnology, which is treated more completely below.

As previously mentioned, the focus of halal acceptability follows the entire value chain, from raw material receipt to manufacturing process. The following discusses a few raw material categories that are commonly used in flavor creation and possible concerns for halal suitability.

**SYNTHETIC CHEMICALS**

Synthetic chemicals are generally a low-risk category for halal as most synthetic materials are of petroleum origin and therefore halal. Production steps involving biotechnology or enzyme activity may be scrutinized by certifiers to assure consistency with halal rules.

**OLEORESINS AND ESSENTIAL OILS**

These materials are derived from vegetable sources and are not in themselves risky; however, attention should be paid to any solvents used in the extraction and residual levels in the material. Also, processing steps involving fermentation or enzyme activity should be evaluated to assure that all components meet halal standards.

**FRUIT JUICES AND CONCENTRATES**

These materials are among the most common natural flavoring ingredients and are by their nature halal unless contaminated or their naturally occurring ethanol is concentrated to high levels. Additives such as stabilizers or emulsifiers should be the subject of scrutiny from certifying bodies.
SUGARS AND STARCHES

The most prevalent concern for sugar processing is the filtration through bone char (charcoal made from animal bones) typically cattle or pig. If the bone char is of porcine origin, it is not permitted for use in halal-certified products. Cattle bones are accepted by most Muslim scholars because of the high heat reached in creating the bone char. Starch may be derived from corn, potato, tapioca, rice, wheat, or other cereal grains. Modified food starch is considered halal but the modification process should be recorded and approved by the certification authorities (as it may involve treatment with enzymes). Modified starches play a large role in manufacturing technologies as they are very useful in encapsulation applications, as well as texturing agents in finished consumer goods.

AMINO ACIDS

Amino acids are widely used in the manufacture of flavors, especially for savory notes and enhancers of umami taste. They may be used as reactants in the aforementioned Maillard processes, and often take the form of crystalline salts of mineral acids (e.g., lysine HCl). With few exceptions they are derived from animal and plant proteins, of which they are constituent monomers (Jahangir et al., 2016). Amino acids can be extracted by hydrolyzing the natural proteins with or without the aid of enzymes. Proteins are, of course, ubiquitous in nature, and the biological source of any amino acid is vital in determination of its halal status. Amino acids derived from pork or other haram animals are not allowed in halal foods, and this prohibition extends to transgenic and biotechnologically derived ingredients (Regenstein et al., 2003).

Of specific note, the amino acid L-cysteine can be derived from human hair, animal hair, animal feathers, or synthetically. Cysteine from human hair is forbidden in halal foods, but material of feather origin may be acceptable if it comes from appropriately slaughtered halal animals. If it is made synthetically or from fermentation, it may also be considered halal, provided that all steps and ingredients are considered appropriate by an accepted halal authority (Regenstein et al., 2012).

LIPIDS AND FATTY ACIDS

Lipids, including fats, fatty acids, waxes, and sterols among others, are widely used in flavors for both their sensory and physical properties. Many vitamins and specific fatty acids are also incorporated in foods for their nutritional value but are seldom confused in this context with “flavors.” In flavor encapsulation systems, lipid derivatives such as lecithin and glycerol ester mixtures are often employed to stabilize the systems and aid the retention of flavoring ingredients. Most of these ingredients are available as natural materials from both plant and animal sources, in addition to synthetic versions. Animal (and biotechnology) sources of such materials will be suspect and must be reviewed by certification authorities for acceptance in finished products.
AREAS OF SPECIAL CONCERN FOR HALAL

BIOTECHNOLOGY

Biotechnology can be broadly defined as the use of biological processes to achieve an industrial goal. Biotechnology in some form has been employed in baking, brewing, and other traditional food preparation methods since the dawn of civilization. Techniques included within the field cover a wide range from the use of whole animal or plant organisms in what can be recognized as conventional agricultural activity, to advanced processes involving recombinant genetic material in these same organisms or in microbes. In the context of food and especially flavor production, these latter methods are increasingly being applied to achieve new properties and more efficient production routes for established materials (Nelson, 2001a,b). Materials of microbial origin should be assessed to assure that growth and culture media as well as the source environment are acceptable for halal. Ingredients from transgenic organisms will also be scrutinized by certification agencies to assure that halal standards are met, where they exist (Nelson and Bullock, 2001). In cases in which no precedent exists, or where halal status is broadly questioned, food and flavor manufacturers are advised to pursue other sources or face repeated challenges and delays in halal certification, as well as potential backlash from clients and consumers.

1. **Enzymes**: Enzymes are protein structures that are produced by biological systems and have the distinguishing characteristic of catalyzing specific chemical reactions, which is their purpose in living organisms. They can be extracted from living tissue and may retain their catalytic activity for use in food or flavor manufacturing processes, among others (Birch et al., 2012; Oort, 2009). As an example, cheese is made using rennet, an enzyme originally extracted from the digestive system of ruminant animals, to cause milk to coagulate into what eventually becomes the curd. Only non-animal (vegetable or fungus derived) rennet or rennet from an appropriately slaughtered halal animal may be used to make halal dairy products (Al-Mazeedi et al., 2013). The genetic provenance of the proteins should be thoroughly documented for review by halal certifiers to assure the acceptability of any enzymes from transgenic organisms. Enzymes from microbial sources must meet the same standards for carriers, growth media, nutrients, and so on, as microbes themselves (Khattak et al., 2011). (See Fermentation.)

2. **Fermentation**: Technically, fermentation is a generic term for microbiological or enzymatic activity, although it is often used beyond the scientific community to refer specifically to alcoholic fermentation, in which sugars are biologically converted to alcohol in a reduced-oxygen environment. It is important to understand that fermentation is widely used in traditional food preparation, where it is responsible for the development of distinct flavors without producing ethanol in any appreciable quantities—cheese making again serves as a typical example. When fermentation products are used in flavoring, the important factors are the sources of the microorganisms and other ingredients in the fermentation system. Bacteria or fungi from unclean
sources are considered haram, as are enzymes extracted from prohibited animals (e.g., porcine lipase). Some special cases may occur, such as in the production of vinegar, where bacteria are used to convert ethanol (the substrate) to acetic acid in a secondary fermentation. These rare cases should be managed in close consultation with an experienced certifying authority. When fermentation does result in the production of alcohol, the quantities permissible in the finished flavoring product are usually minute. The determination of the halal status for a product of fermentation usually requires complete disclosure to the halal certifier of the origin and constituents of every process step, including the source of transgenic material as well as any ingredients, substrates, reagents, nutrients, or other additives used in the creation, propagation, or extraction of the active enzyme or organism. Fermentation processes that are associated with the manufacture of alcoholic beverages are not considered halal, and by-products from such processes are likewise prohibited in halal food and flavors.

3. GMO: The acceptability of genetically modified organisms is generally a topic of much debate, and in the context of halal foods is no exception. For halal purposes, the areas of possible concern are the transfer of genes from animal to animal, insects to plants, and animal to plants. In these instances, it is possible to introduce the genes of a haram animal/insect into an otherwise acceptable ingredient source. While the details of this topic are beyond the scope of this chapter, it is worth noting that GMO status should be a data collection point for raw materials and this information must be available if requested by the halal certification body.

Animal-Derived Materials

There are many ways animal material can be introduced into flavorings. Processing aids, production methods, and even growth media in fermentation applications, each may contribute to “hidden” animal ingredients in raw materials. If any animal derivatives are present in the ingredients, they must be found acceptable by the halal certifying body before being included in a halal-certified product. Good record keeping and quality programs will aid in identifying raw materials that contain animal by-products. It is important that if the flavor requires using meat or poultry products that the animal has been religiously slaughtered according to Islamic law. Slaughtering records, or a validated halal certificate, must be maintained by the flavor manufacturer and approved by the certifying agency prior to use in halal production. A few other animal-derived materials that deserve note are:

1. Castoreum, skatole, civet: These are examples of (non-halal) animal-derived materials that were sometimes used in food manufacturing due to their sensory characteristics and “natural” classification but have been nearly universally replaced by cheaper synthetic versions or less expensive and more widely available natural ingredients. If they are still used, certification authorities will require product reformulation to remove them prior to certification.
2. **Fish and crustaceans:** Depending on the consumer market and the interpretation of Quranic law by the regional halal authority, some fish and crustaceans may be considered haram.

3. **Insects:** Again, this will depend on the interpretation of Quranic law by the halal authority. Some insects are considered permissible for use; carmine, a natural coloring agent, is a common example of an insect derivative that may be present in foods or flavors and which may or may not be considered acceptable for halal use.

4. **Meat flavoring:** As long as the product is entirely derived from halal sources (many “meat” flavors are, in fact, completely vegetable-based), meat flavorings can be approved as halal. Care should be exercised with meat flavoring that mimics bacon, ham, or pork in any way. The naming convention of the flavor is important so that a distinction can be made for those religiously observant (a haram name cannot be used for a product that requires halal certification). Of course, animal ingredients used in meat flavors must observe halal slaughter requirements.

**Alcohol**

The type of alcohol of concern in halal-certified products is ethanol or ethyl alcohol. In the context of halal, it is important to distinguish ethanol from other organic compounds that are classified chemically as alcohols, since the origin of the prohibition of ethanol is tradition in many cultures of use as *Khamr* or recreational intoxicant.

Many flavoring materials are chemically classified as alcohols and pose no risk to the halal status of food but are often questioned (particularly by consumers) because of this association. Even the halal status of ethyl alcohol is not definitive, due to its natural presence in many materials that are promoted as beneficial in Islam, such as vinegar and fresh fruit juice (Riaz, 1997).

Ethanol from alcoholic beverages is strictly prohibited at any level in halal food. For ethyl alcohol to be permitted at any level, it must be naturally present in the raw material or produced as “industrial” ethanol (not part of a process specifically meant for beverage production such as fermentation of grapes for wine). When using industrial ethanol in flavorings, the halal certifier will often determine the status based on its origin because halal certificates are not available for ethyl alcohol. Ethanol that occurs naturally can be commonly found in derivatives or by-products of natural materials containing sugar, such as orange juice.

Ethanol is necessary in some production processes for efficiency (washed oils, etc.) and regulatory (e.g., vanilla) purposes. It has many functional applications, and can be used for extraction, as a processing aid, flavor carrier, solvent, or even as a disinfectant. Ethanol may be permissible in these capacities as long as the total amount of remaining ethanol in the finished flavoring (which is still an ingredient) is no more than 0.5%. Most certifying agencies globally are in agreement that this level is an acceptable cutoff for flavoring ingredients. It is important to note that the final consumer product will have a much lower acceptable level depending on the requirements of the final product halal certifier. In general, flavoring materials account for a very small portion of the total makeup of any consumer product (typically less
than 1%, but this may vary widely depending on the application) (Halal Consumer Group, 2012).

PRODUCTION PROCESSES

As mentioned earlier in this chapter, the constraints related to manufacturing halal flavors are minimal and relatively easy to manage in a production facility as long as good quality assurance programs are already in place. Halal programs review the entire value chain from raw materials upon receipt through storage and manufacturing, equipment cleaning procedures, and finally labeling and shipping. The requirements for halal can be integrated into a HACCP, GMP, or food safety program, or can at least take advantage of the processes and information used in these programs. The following guidelines form the basis of a halal manufacturing program:

1. The finished product must be free of any derivative of animals that are forbidden, or other haram materials.
2. The finished product must not be prepared, processed, or manufactured using utensils or equipment that are considered haram by Islamic Laws.
3. During preparation, processing, and storage, the finished product should not come into contact with haram items.

RAW MATERIAL RECEPTION

A critical point of raw material review is to determine if any pork was used to manufacture/extract/obtain the raw material. As it can be such a costly mistake to use a pork-derived raw material, screening raw material suppliers is a vital component of the halal program. If a porcine derivative is present in any raw material, it is important that this information be clearly visible to manufacturing personnel, and these items must be strictly segregated and used with care. Any vessel, measuring instrument, or equipment that comes in contact with a pork-derived raw material cannot be used for the production of halal flavors. This strict segregation extends to reception, quality control evaluation, and to storage.

EQUIPMENT SEGREGATION

All equipment and vessels within the manufacturing facility should be dedicated to either pork contact or pork-free resources. It is an important distinction that items can be non-halal without being pork-derived. The clean-up after using pork is more stringent than that for other haram materials. While maintaining pork contact and pork-free resources can seem imposing when establishing a halal program, it is quite straightforward to manage in practice if properly implemented. Clearly labeling materials as pork-derived or not (whether by color coding or other means) will assist with proper resource management. Manufacturing non-halal items that do not contain porcine derivatives on pork-free equipment is permissible as long as approved cleaning standards are used between every batch. Using a systematic approach to
regulating equipment enhances a manufacturer’s ability to conform to and apply halal requirements at a global (or multi-plant) level.

**CROSS-CONTAMINATION, HACCP CONTROLS**

Proper cross-contamination protocols are vital to ensure that the integrity of the pork-free equipment remains intact. If GMP are followed and validated, it stands to reason that the facility will be in a good position to manufacture in accordance with halal principles. The Hazard Analysis Critical Control Point (HACCP) framework is a process control system that identifies where hazards might occur in the food production process and puts into place stringent actions that must be taken to prevent the identified hazards from occurring. The chance of a hazard occurring is reduced through strictly monitoring and controlling the identified control points at each step of the process. Allergen cross-contamination is considered a chemical hazard in the HACCP programs, and is controlled with the proper cleaning of equipment. If pork status is treated in a similar fashion, the risk of contamination should be adequately controlled for the purposes of halal certification (Bas et al., 2006, 2007).

**CLEANING AND STORAGE**

The cleaning methods used during the manufacturing process must also meet the halal standard. If ethanol is used as a cleaning agent, any trace must be removed or it must be accounted for in the final calculations of ethanol in a product. Other cleaning agents should be reviewed to make sure they are from acceptable sources (be cautious of pig bristles on brushes). Cleaning according to GMP methods between every production run will be sufficient to re-qualify the equipment used in manufacturing flavors that may contain certain non-halal products other than pork. These standards of cleanliness are required to extend to the entire manufacturing property, meeting GMP standards, and remaining free from insect and other pest infestations.

Halal-certified flavors are a necessary part of consumer goods manufacturing. As flavors can be processed in a variety of ways and include a large number of ingredients in their production, halal certification provides assurance to food manufacturers (and ultimately the consumer) that all ingredients in their food are suitable for those following a halal diet. Implementing and following a halal program is a straightforward process that can be successful with the understanding of a few simple halal principles and a close working relationship with the certifying body.

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