

FOOD PRESERVATION TECHNOLOGY SERIES



Advances in Fresh-Cut Fruits and Vegetables Processing

Edited by
Olga Martín-Belloso
Robert Soliva-Fortuny



CRC Press
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Fresh-Cut Fruits
and Vegetables
Processing***

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Advances in Fresh-Cut Fruits and Vegetables Processing

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Preface

The fresh-cut fruit and vegetable market is clearly expanding worldwide. In developed countries, those commodities are provided by the food industry, while in the rest of the countries, these products are prepared under uncontrolled conditions that may pose a risk for consumers. Conscientious of the growing interest in these kinds of products, researchers are increasing efforts to offer adequate technologies and practices to processors in order to assure safety while keeping the highest nutritional properties and best sensory properties of the fresh fruits or vegetables. This has led to a significant increase in the amount of new scientific data available. However, this information needed to be presented in a critical and feasible way.

This book is the result of the valuable contribution of experts from industry, research centers, and academia working on different topics regarding fresh-cut produce. We are sincerely thankful to all of them.

The Editors

Olga Martín-Belloso holds a PhD in chemical sciences. She belonged to the National Technical Center of Canned Vegetables from 1984 to 1992 when she joined University of Lleida, Spain. She is presently a professor of Food Science and Technology and head of the research unit on New Technologies for Food Processing.

Her research interests are focused on the development of ready-to-eat, safe, and healthy products by combining already existing processing technologies with novel techniques, as well as the valorization of wastes generated by the fruits and vegetables processing industries.

Pulsed electric fields and intense pulsed light treatments, edible coatings, modified atmosphere packaging, as well as the use of natural antimicrobial and antioxidant substances are among the key technologies developed by her research group.

She has authored more than 200 research papers, several books, book chapters, and patents. She also belongs to the editorial board of recognized journals and is a member of several executive committees of international scientific organizations, such as the Nonthermal Processing Division of the Institute of Food Technologists (NPD-IFT) and the European Federation of Food Science and Technology (EFFoST). In addition, she has been invited as a speaker in numerous international meetings and courses.

Robert Soliva-Fortuny holds a PhD in food technology. He worked on research and development projects for a fruit processing company from 2002 to 2005. In 2005 he was awarded by the Spanish government with a research fellowship. He is currently associate professor at the Department of Food Technology at University of Lleida, Spain, and member of the research unit on New Technologies for Food Processing.

His research activities are focused on food processing and product development. He has authored more than 70 peer-reviewed research papers and several book chapters.

The development of high-quality, safe, and healthy ready-to-eat products by combining the already existing processing technologies with novel techniques is one of his main research activities. He is actively participating in several research projects dealing with the application of nonthermal processing technologies such as high-intensity pulsed electric fields or intense pulsed light treatments.

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1 The Fresh-Cut Fruit and Vegetables Industry

Current Situation and Market Trends

*M. Alejandra Rojas-Graü, Edward Garner,
and Olga Martín-Belloso*

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1.1 INTRODUCTION

Fresh-cut fruit and vegetables, initially called minimally processed or lightly processed products, can be defined as any fresh fruit or vegetable that has been physically modified from its original form (by peeling, trimming, washing, and cutting) to obtain 100% edible product that is subsequently bagged or prepackaged and kept in refrigerated storage (IFPA, 2005). Fresh-cut produce includes any kind of fresh commodities and their mixtures in different cuts and packaging. Items such as bagged salads, baby carrots, stir-fry vegetable mixes, and fresh-cut apples, pineapple, or melon are only some examples of this type of product.

The production and consumption of fresh-cut commodities is not new. According to the International Fresh-Cut Produce Association (IFPA), fresh-cut products have been available to consumers since the 1930s in retail supermarkets. However, the fresh-cut industry was first developed to supply hotels, restaurants, catering services, and other institutions. For the food service industry and restaurants, fresh-cut produce presents a series of advantages, including a reduction in the need of manpower for food preparation, reduced need of special systems to handle waste, and the possibility to deliver in a short time, specific forms of fresh-cut products (Watada et al., 1996). Yet it has not been until the past two decades that fresh-cut fruit and vegetable

products have gained popularity and penetration in the produce business as a result of a general trend to increase fresh fruit and vegetable consumption (Mayen and Marshall, 2005). The fresh-cut fruit and vegetable industry is constantly growing mainly due to the consumers' tendency to consume healthy and convenient foods and their interest in the role of food in improving human well-being (Gilbert, 2000; Ragaert et al., 2004). In fact, organizations such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), United States Department of Agriculture (USDA), and European Food Safety Authority (EFSA) recommended an increase of fruit and vegetable consumption to decrease the risk of cardiovascular diseases and cancer (Allende et al., 2006). In countries such as the United States, the consumption of fresh whole fruit increased from 282.1 to 284.6 lb/year per capita during the last decade of the 20th century (USDA, 2003), probably as a consequence of an increased public awareness regarding the importance of healthy eating habits.

On the other hand, fresh-cut products are a very convenient way to supply consumers with ready-to-eat foods. Washed, bite-size, and packaged fresh fruit and vegetables allow consumers to eat healthy on the run and to save time on food preparation. For instance, the availability of fresh-cut fruits in vending machines in schools and at workplaces would constitute an excellent strategy to improve the nutritional quality of snacks and convenience foods in a time when obesity and nutrition-related illnesses affect large percentages of the population (Olivas and Barbosa-Cánovas, 2005). In addition to the convenience, there are other reasons for the success of fresh-cut produce, such as the absence of waste material. Waste is generated in peeling and coring fruit. However, when utilizing fresh-cut produce, 100% is consumable, and there is a substantial decrease in labor required for home produce preparation and waste disposal (Garcia and Barrett, 2005).

A study conducted by the IFPA revealed that 76% of surveyed households buy fresh-cut produce at least once a month, and 70% buy fresh-cut fruit every few months (IFPA, 2003). About 30% of consumers prefer fresh-cut fruits and vegetables to their unprocessed equivalents. In addition, Sonti et al. (2003) indicated that women are more likely to buy fresh-cut fruit than men, and as the income level increases, the probability of consuming fresh-cut fruits also increases.

Fresh-cut fruits and vegetables, prepackaged salads, locally grown items, and exotic produce as well as hundreds of new varieties and processed products have been introduced or expanded since the early 1980s. Supermarket produce departments carry over 400 produce items today, up from 150 in the mid-1970s and from 250 in the late 1980s. Also, the number of ethnic, gourmet, and natural food stores that highlight fresh-cut produce continues to rise. Some fresh-cut produce currently available in supermarkets is included in Table 1.1. Because of their convenience and consistent quality, packaged salads continue to be the most popular fresh-cut product. Today, packaged salads account for about 7% of all produce department sales. In fact, in countries such as the United States, consumers have made packaged salads the second-fastest-selling item in grocery stores, trailing only bottled water (Bhagwat, 2006). According to Garrett (2002), organically grown fruits and vegetables are another segment of the fresh produce industry that experienced strong growth in the 1990s, including both whole commodities and fresh-cut products.

TABLE 1.1**Prepared Fruit, Leafy Salad, and Mixed-Tray Salads***

Prepared Fruits	Leafy Salads	Mixed-Tray Salads
Classic salad	Sweet + crunchy salad	Potato + egg salad
Pineapple chunks	Watercress	Sweet + crunchy salad
Luxury fruit salad	Crispy salad	Lettuce + tomato + cucumber + celery
Melon medley	Iceberg lettuce	Mediterranean salad
Melon + grape	Italian salad	Fresh + crispy
Pineapple pieces	Rocket salad	Ribbon salad lettuce + cucumber
Sliced melon selection	Rocket	Mixed pepper salad
Tropical fruit salad	Baby leaf salad	Prawn + pasta salad
Fruit salad	Spinach + watercress + rocket salad	Tuna niçoise
Pineapple slices	Mixed salad	Pasta + cheese salad
Fresh fruit salad	Alfresco salad	Mixed salad white + red cabbage
Mango chunks	Bistro salad	Sweet pepper salad
Grape + kiwi + pineapple	Caesar salad	Oriental edamame soya bean
Apple + grape	Italian leaf salad	Greek salad
Pomegranates	Herb salad	Crunchy lettuce salad + cucumber
Fruit fingers	Ruby salad	Crisp mixed salad
Fruit selection	French style salad	King prawn + pasta salad
Rainbow fruit salad	Crisp mixed salad	Tuna + pasta
Mango + lime wedge	Fine cut salad	Egg salad
Mixed fruit salad	Crispy leaf salad	Poto + peas + bean salad
Fruit cocktail	Leaf salad	Pasta + pepper salad
Seasonal melon medley	Watercress salad	Salmon + potato
Mango pieces	Four leaf salad	Chicken + bacon Caesar salad
Grape + melon	Seasonal baby leaf salad	Avocado spinach + tomato
Apple segments	Mixed leaf salad	King prawn noodle salad
Melon selection	Crunchy mixed salad	Tomato + cheese pasta salad
Summer berry medley	Santa plum tomato salad	
Apple slices + grapes	Tender leaf salad	
Fruit medley	Watercress + spinach + rocket	
Red grape		

Source: Garner, E. 2008. European trends in fresh-cut convenience. Conference presented at the Freshconex, Berlin, Germany

* 52-week ranking ending December 2007.

1.2 GLOBAL MARKET TENDENCIES

Today, there are more fresh-cut fruit and vegetables being consumed as people seek to replace unhealthy snack foods with healthier fruit and vegetable products. This trend has led the fresh-cut industry to increase investment in research and development to address issues regarding raw product supply, packaging technology, processing equipment, and refrigeration. After its popularity in the fast food sector,

fresh-cut produce became available at a retail level. This led the way for expansion in the industry, which continues, including more recent additions of fresh-cut fruits at quick-service restaurants and in retail stores.

The production and commercialization of fresh-cut fruits has grown rapidly in recent years, but fresh-cut vegetables, salad in particular, dominate the production of minimally processed foods. According to Mayen and Marshall (2005), the emerging fresh-cut fruit sector will probably overshadow salad sales in the future, because fresh-cut fruits are more attractive to young consumers and aging baby boomers and in general are more likely to be consumed as snack products. In addition, fresh-cut fruits on average have higher margins than bagged salads from retail, which will result in ample space for display in the stores.

1.2.1 AMERICAN TRENDS

Recently, there has been a boom of fresh-cut produce all over the world, especially in many American countries; however, the main production and consumption are concentrated in North America, with the United States as the leader.

In the United States, fresh-cut produce first appeared in retail markets in the 1940s, but second-quality, misshapen produce was used, quality was unpredictable, and shelf life was limited. In the mid-1970s, fast food chains were using shredded fresh-cut lettuce and chopped onions. In the mid-1980s, salad bars opened, and fresh-cut produce start replacing canned products (Garrett, 2002). In fact, the main expansion of fresh-cut fruits and vegetables in the United States occurred in the food service sector. In the 1980s, fast food restaurants like McDonald's and Burger King were booming in the United States, so fresh-cut products used in their salad bars and ready-to-eat salads, especially fresh-cut lettuce, were the more required items. In effect, in 2006, in the United States alone, McDonald's used 80 million pounds of salad greens (including spring mix), 100 million pounds of leaf lettuce and iceberg lettuce on sandwiches, 30 million pounds of tomatoes, 54 million pounds of apples for apple dippers and fruit and walnut salad, and 6.5 million pounds of grapes (McDonald's, 2006). Nowadays, fresh-cut produce is one of the fastest growing food categories in U.S. supermarkets, with packaged salads the most important item sold (Figure 1.1). Additionally, the most popular Stock Keeping Unit (SKU)—washed, peeled, and packaged—in the United States is mini carrots, available in a number of sizes (USDA, 2003).

Fresh-cut fruit and vegetable sales have grown to approximately \$15 billion per year in the North American food service and retail market and account for nearly 15% of all produce sales. According to the United Fresh Produce Association (2007), the largest portion of U.S. fresh-cut produce sales at retail is fresh-cut salads, with sales of \$2.7 billion per year. However, the fast food sector is increasing the demand for packaged fresh-cut fruits by offering healthier choices on their menus. Scott (2008) reported that the U.S. sales of fresh-cut fruit items increased for every product, ranging from 7% to 54% growth. Melons were the segment with a faster growth. This trend is expected to continue at least during the next few years. A number of consumer market research reports have predicted that the demand for fresh-cut fruit products will continually increase, with food service establishments and school

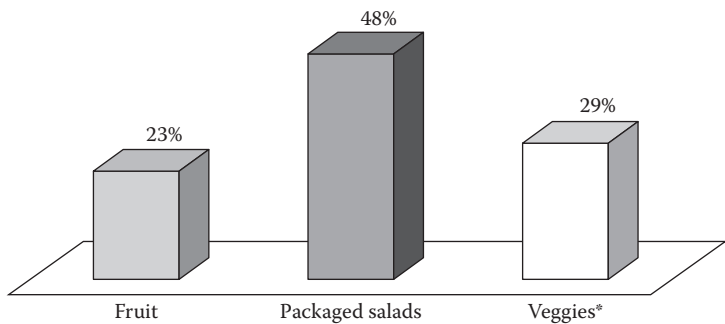


FIGURE 1.1 Fresh-cut produce sales via supermarket channels, 52-week sales ending June 30, 2007, \$6 billion total. *Carrots = 45% of vegetables. (Adapted from Cook, R. 2008. The dynamic U.S. fresh produce industry: an industry in transition. *Fresh Fruit and Vegetable Marketing and Trade Information*, University of California, Davis.)

lunch programs being major customers (Anonymous, 2000; Gorny, 2003). According to a study reported by the Perishables Group in 2008, mixed fruits and vegetables, watermelon, pineapple, carrots, and mushrooms have the most important sales and volume in U.S. fresh-cut items (Figure 1.2).

Currently in the United States, the most important company in fresh-cut fruit sales is Ready Pac, with a market share of 23%, followed by private-label store brands (31%), Del Monte (13%), Country Fresh (7%), Club Fresh (3%), and Fresh Express (1%), according to Information Resources, Inc. (2003). Many of these companies’ fresh-cut fruit includes products such as pineapple, melons, grapes, citrus, apples, and kiwi. In the case of fresh-cut vegetables, Fresh Express and Dole reached shares of 42% and 48%, respectively, of retail packaged salad sales in 2005, followed by Ready Pac (8%) and other companies (4%) (PMA, 2006). Many kinds of lettuces, such as radicchio, arugula, and red oak, have gained in popularity in past years because of their inclusion in fresh-cut salad mixes and on upscale restaurant menus. In fact, salad blends reached a share of 37% of the salads market in 2005, followed by iceberg lettuce (13%), romaine lettuce (11%), garden salads (8%), salad kits (6%), organic salad blends (4%), premium garden blends (83%), shredded lettuce (3%), spinach (3%), and other (12%) (PMA, 2006).

1.2.2 EUROPEAN TRENDS

In Europe, fresh-cut products were introduced in France in the early 1980s by Florette Group. It was the first production unit of fresh-cut vegetables in Europe which subsequently started various activities to export to other countries such as the United Kingdom, Italy, and Switzerland. Fresh-cut products have been adapted to each country according to consumer preferences, production, distribution, and legislation. In Spain, for instance, fresh-cut products were introduced by Vega Mayor, which were present on the Spanish and Portuguese markets since 1989. Twenty years later, Vega Mayor was acquired by the Florette Group and at the moment is the Spanish leader in the fresh-cut vegetables market. Currently, the main manufacturers and

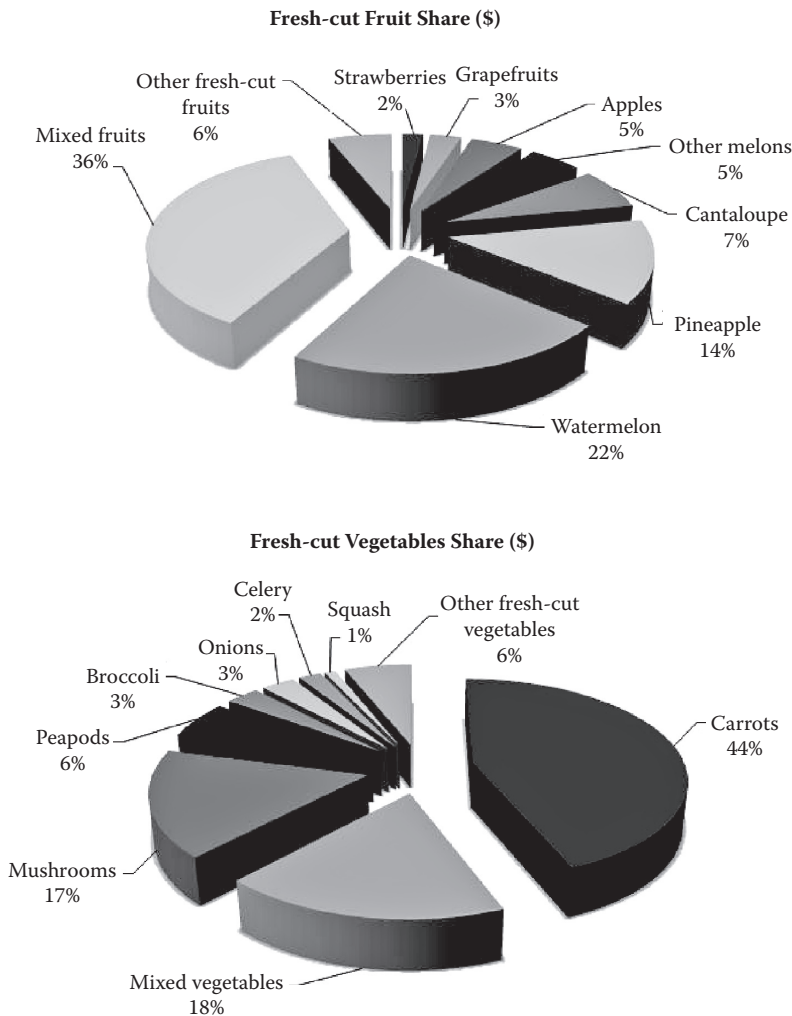


FIGURE 1.2 Fresh-cut vegetables and fruits share in the United States (in dollars). (Adapted from Perishables Group. 2008. U.S. fresh cut produce trends. Conference presented at the Freshconex, Berlin, Germany.)

traders operating in the Spanish market are Vega Mayor, Verdifresh, Kernel, Tallo Verde, Sosegol, and Primaflor (Figure 1.3). However, other producers in the food industry have started to commercialize their new fresh-cut products in the last years. For instance, Vitacress, which is the second firm leading in sales in the English market, after their introduction and success in Portugal, is now beginning their entry into the Spanish market through Vitacress Iberia. Another example is the company Cofrusa, which offers fresher products, such as salads, ready-to-eat vegetables, and, more recently, individual portions of fresh-cut fruits.

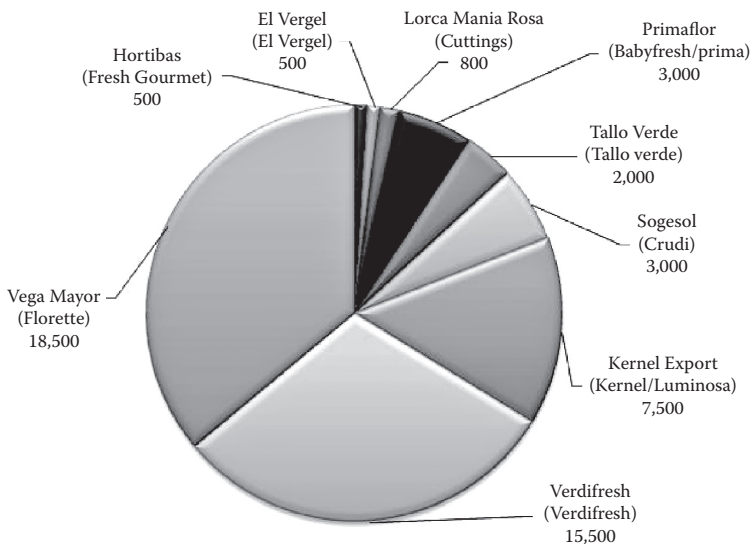


FIGURE 1.3 Ranking of fresh-cut fruits and vegetables manufacturers in Spain. Data correspond to 2004 or estimates for 2005 in tons (t). (Adapted from Alimarket, www.alimarket.es.)

The European markets for fresh-cut fruits and vegetables vary between countries. In some, there is a wide range available in supermarkets, and in others, ready-to-eat food is practically a novelty.

The fresh-cut industry is rising in many European countries with the United Kingdom, France, and Italy as share leaders. Over the last decade, ready-to-eat mixed salad packs have been one of the greatest successes of the UK food industry. The United Kingdom is the leader of the sector, supplying 120,000 tons of fresh-cut salads in 2004, equal to €700 M (\$840 M U.S.); France followed with 77,000 tons considering fresh-cut and grilled/steamed vegetables. In Italy, the sales exceeded 42,000 tons of production, corresponding to €375 M (\$450 M U.S.) in 2004 (Nicola et al., 2006). Currently, the countries with higher growth in the fresh-cut fruits and vegetables market are Germany, The Netherlands, Spain, and United Kingdom (Figure 1.4) (Garner, 2008). According to the latest data released by Afhorla (the Spanish Association of Washed and Ready-to-Use Fruit and Vegetables) between January and April 2006, Spanish sales had reached 14,675 tonnes, 18.5% more than the same months in 2005. Fresh-cut products represent 5% of all fruit and vegetables consumed in Spain. Some studies indicate that this segment could grow by more than 25% annually.

The average European consumes up to 3 kilos of fresh-cut products a year, but the differences are quite substantial within Europe. For instance, in the United Kingdom the rate is 12 kg per capita per year, France comes second consuming half that of its neighbor with 6 kg per capita, and Italians consume around 4 kg. Other countries where fresh-cut foods are well established, although far less than those already mentioned, are Belgium, The Netherlands, and Germany. In the countries

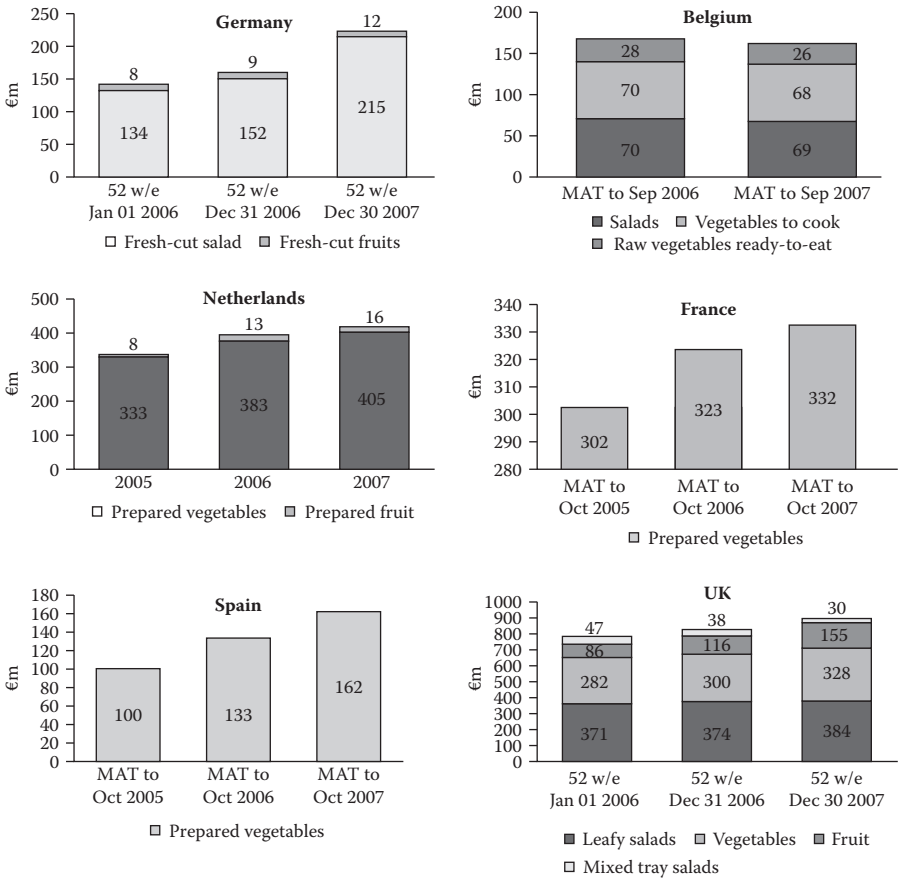


FIGURE 1.4 Fresh-cut fruit and vegetable European market trends. (Garner, 2008.)

of Eastern Europe, with increasingly healthier economies, they are beginning to see great growth in this sector, a development that has not been ignored by the large international holding companies.

1.2.3 ASIATIC TRENDS

Fresh-cut products were introduced in Korea and Japan in the 1990s and 1980s, respectively. Initially, in both countries the main user of fresh-cut products was the food service industry for school meals and restaurants, but in recent years, the consumption has expanded to retail markets (Kim and Jung, 2006). In China, the market for fresh-cut products has been growing since the late 1990s, with more Western fast food industries entering and developing in the Chinese market.

Korea is one of the fastest-growing markets in Asia, with a wide variety of products in the retail segment. In 2006, there were 102 companies producing fresh-cut produce. No fresh-cut fruits were found on supermarkets until the late 1990s

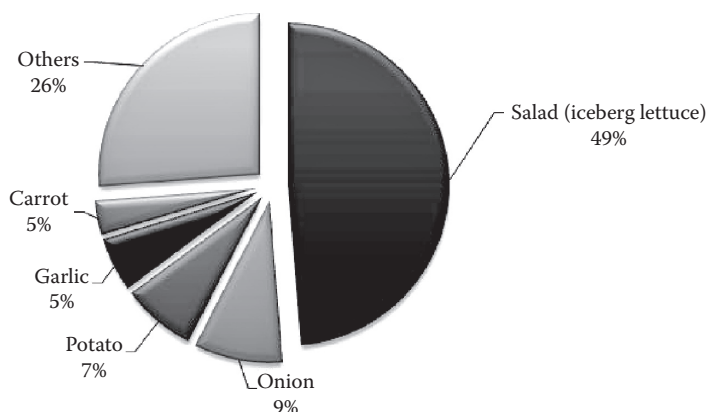


FIGURE 1.5 Proportion of fresh-cut vegetable items based on processing amount in Korea in 2005. (Adapted from Kim, J.G. 2007. Fresh-cut market potential and challenges in Far-East Asia. *Acta Horticulturae* 746: 33–38.)

in Korea. However, the fresh-cut fruits industry has recently enjoyed double-digit growth rates, reaching an estimated \$50 million in 2006 (Kim, 2007). Despite this growth, fresh-cut vegetables continue to dominate the production of fresh-cut items, with salad made from iceberg lettuce the most popular fresh-cut produce, comprising 48.7% of total fresh-cut vegetables (Figure 1.5).

According to the Korean Fresh-cut Produce Association (KFPA), in Korea, the fresh-cut produce market reached approximately \$1.1 billion in 2006, up from \$530 million in 2003. In Japan, the sales of fresh-cut produce have grown from approximately \$1 billion in 1999 to \$2.6 billion in 2005, which is about 10% of total fresh produce sales (Izumi, 2007).

In Japan, the food service sector, which supplies produce to restaurants, fast-food outlets, and school meals, makes up about 66% of the total fresh-cut market. Sales of fresh-cut produce in the retail sector, including supermarkets and convenience stores, are \$0.9 billion, 34% of the total market (Kim, 2007). According to a study published by the Association of Minimally Processed Fruits and Vegetables (AMPFV) in 1999, there are 161 enterprises producing fresh-cut products in Japan (AMPFV, 2000).

Iceberg lettuce, onion, cabbage, Japanese radish, edible burdock, potato, Chinese cabbage, pumpkin, sweet pepper, cucumber, carrot, watermelon, pineapple, and melon are the most popular fresh-cut vegetables and fruits in Japan. In this country, manufacturers such as Dole, for example, offer cut lettuce, cabbage mixes, coleslaw, bean salad, tomato salad, onion salad, corn salad, Caesar salad, and a wide variety of specialty mixes, which make up the bagged category. According to the AMPFV (2004), in Japan, the total input of vegetables to fresh-cut production was reported to be 92,672 tonnes in 2002.

Although no exact data show the scale of the fresh-cut fruits and vegetables market in China, China will become the largest consumer of these products in the future. For example, in Beijing, a new fresh-cut factory was established 3 years ago,

and sales reached 3900 tons by 2006. It is estimated that the fresh-cut fruits and vegetables market in China will increase at a rate of 20% annually (Zhang, 2007).

1.3 FINAL REMARKS

Fresh-cut fruits and vegetables are commodities with a rapidly growing sector in the food industry, with both retail and food service outlets. At the moment, the main factor that has promoted and maintained fresh-cut sales is the technology. However, permanent innovations are necessary to drive new growth in this sector. Use of innovative packaging technology that could improve product quality and shelf life, new fruit mixtures with more variety, incorporation of flavors, or the use of steamer bags for vegetables, are just a few considerations that could expand the markets of fresh-cut products. Worldwide, there is a wide range of vegetables that could be used to broaden and increase the product offerings in the market. However, in many countries, it is necessary to improve preparation and preservation techniques with the purpose of keeping the product safe and of high quality long enough to make the distribution of fresh-cut commodities feasible and achievable.

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2 Regulatory Issues Concerning the Production of Fresh-Cut Fruits and Vegetables

Menno van der Velde

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2.1 INTRODUCTION

2.1.1 THE TYPES OF LAW

The introduction of fresh-cut fruits and vegetables (FcFV) on the market as a new type of product extended the production chain of human food. It added some new challenges for producers, but it did not introduce a new type of law.

FcFV are subjected to the food law of the country where they are grown, harvested, processed, transported, and sold to consumers by caterers and retailers. The applicable food law multiplies when they are traded internationally. The food laws of all participating countries are then applicable, as is international food law, if only in an effort to harmonize the laws of the different legal systems. The Codex Alimentarius Commission (CAC) is the international intergovernmental organization for food standards, guidelines, and recommended practices. An intergovernmental organization can only make recommendations to the governments of the member states, but the Codex Alimentarius, the collection of CAC food law, nevertheless, has much authority.

National and international food laws makes use of many instruments: binding legislation and regulations, along with several voluntary instruments, such as good practices, especially Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs), for the successive stages in the food production chain with other good practices for the remaining stages.

GHP follow the produce from the beginning to the end of the production chain. Systems based on the Hazard Analysis and Critical Control Point (HACCP) principles are equally applicable throughout the production chain. Governments publish guidance documents to explain their legislation; sometimes they prefer the assistance of voluntary codes made by the food businesses. Some of these voluntary codes are approved by public authorities. Letters from public law authorities remind the food business operators of the prescribed levels of hygiene, and the regulatory powers that could be used if the industry continues to fail to live up to the expectations that are also legal requirements.

In short, there is a varied array of binding and nonbinding law. Although the term *binding law* may seem to be a tautology, and the term *nonbinding law* an internal contradiction, both types of law exist. The nonbinding legal instruments are very important in food law.

The simple structure of binding rules, usually made in legislation for food safety, more specific legislation for food hygiene, still more specific rules for fresh produce, and finally detailed legislation for fresh-cut fruits and vegetables does not exist. It is complicated by the practice of mixing legislation with non-binding law. Mixing takes place at two levels: legally binding instruments are combined with voluntary instruments that can be used as an alternative, under certain conditions set by the law. On a deeper level, legally binding instruments take the essential elements of a voluntary instrument such as a GHP and prescribe it as the law. Enforcement of these binding rules is then an alternative to voluntary good practices. The result is a complicated collection of law, soft and hard, voluntarily accepted and binding, national and international, intergovernmental and supranational, governmental and private. A selection of all of these different kinds of relevant law is presented in this chapter. It is representative but by no means complete.

2.1.2 THE PRODUCE

FcFV are the results of an extended food production chain. Final preparation of this food has been transferred from consumers and caterers* to a new set of producers who depend on new production methods for ready-to-eat food and the logistics of transports, distribution, and wholesale to get the FcFV in time to the retailers and caterers where the consumers will buy them.

The production of this type of ready-to-eat food requires not only additional steps in the production process but also additional food hygiene measures. Preparation of FcFV removes their natural protection against desiccation and contamination. It increases the contact surfaces between the produce and the oxygen in the atmosphere, frees the moisture, and presents abundant nutrition and ideal living conditions to a host of unwanted creatures. It also excludes the use of production processes that could eliminate this contamination, such as freezing or heating to lethal levels, and sweetening, acidifying, and other countermeasures to deal with microbial and other contamination.

The production of FcFV requires increased control over fruits and vegetables, especially backwards in the primary production stage where many potential causes for fresh-cut contamination attach themselves easily to the raw material and are difficult to remove.

The second major concern is the part of the production chain after the FcFV have been made: ways have to be found to preserve their freshness during transport,

* The word *caterer* is used here to indicate restaurants, canteens, schools, hospitals, and similar institutions where food is offered for immediate consumption. Compare the phrase “foods for catering purposes” in Codex Alimentarius Commission, CODEX STAN 1-1985 Labelling of Prepackaged Foods, http://www.codexalimentarius.net/web/more_info.jsp?id_sta=322.

distribution, catering, or retail, and even beyond the production chain, because food safety has to be guaranteed by the producers for the entire shelf life—that is, either the period preceding the “use by” date or the “minimum durability date,” as defined in Articles 9 and 10 of Directive 2000/13/EC.*

There are several items for which the law for fresh-cut produce has to be different from the law for fresh produce.

2.1.3 EXAMPLES OF BINDING AND NONBINDING LAW ON FRESH-CUT FRUITS AND VEGETABLES

FcFV have entered food hygiene law in various ways and to various degrees. EC legislation on microbiological contamination is an example of binding law. The EC has set food safety criteria for *Salmonella* in precut fruits and vegetables[†] and for *Listeria monocytogenes* in relation to three ready-to-eat foods.[‡] A food that does not satisfy a food safety criterion is banned from the market and banned from export and import. It also means that food business operators have to install a testing program and conduct studies to investigate compliance with the criteria throughout the shelf life of their products.

Process hygiene criteria have been set for *Escherichia coli* in relation to pre-cut ready-to-eat fruits and vegetables.[§] Food business operators have to ensure that the process hygiene criteria are met in the supply, handling, and processing of raw materials and foodstuffs under their control. Failure to meet the food safety criteria means the duty to destroy the produce when no alternative use is possible. Failure to meet the process hygiene criteria creates the obligation to improve the processing or the raw material.

FcFV have also attracted nonbinding law.

The CAC made voluntary rules in the “Annex for Ready-to-Eat Fresh Pre-cut Fruits and Vegetables” to the “Code of Hygienic Practice for Fresh Fruits and Vegetables.”[¶]

* Article 2(f) European Community, Commission Regulation (EC) No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs, OJ L 338, 22.12.2005, p. 1–26 <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2005R2073:20071227:EN:PDF> and Directive 2000/13/EC of the European Parliament and of the Council of 20 March 2000 on the approximation of the laws of the member states relating to the labeling, presentation, and advertising of foodstuffs, OJ L 109, 6.5.2000, p. 29, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0013:20071129:EN:PDF>.

[†] Food category 1.19, Chapter 1. Food safety criteria. Annex I Microbiological criteria for foodstuffs, Commission Regulation (EC) No. 2073/2005.

[‡] Food categories 1.1, 1.2, and 1.3, Chapter 1. Food safety criteria. Annex I Microbiological criteria for foodstuffs, Commission Regulation (EC) No. 2073/2005.

[§] Food category 2.5.1, 2.5 Vegetables, fruits, and products thereof, Chapter 2. Process hygiene criteria. Annex I Microbiological criteria for foodstuffs, Commission Regulation (EC) No. 2073/2005.

[¶] Codex Alimentarius Commission, CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables, Annex I, Annex for Ready-to-eat Fresh Pre-cut Fruits and Vegetables, http://www.codex-alimentarius.net/web/more_info.jsp?id_sta=10200.

The United States Food and Drug Administration (FDA) published the “Guide to Minimize Microbial Food Safety Hazards of Fresh-cut Fruits and Vegetables” as voluntary guidance against the background of FDA’s binding regulatory powers.*

2.2 NONBINDING LAW

2.2.1 THE CODEX ALIMENTARIUS

The CAC decision-making process is structured to involve as many governments as possible and to prepare decisions in as many steps as are necessary to achieve consensus. Of course, other international intergovernmental organizations can use the Codex in their practice, and a significant development is the use of the Codex as the source of law for decisions in the dispute settlement procedures of the World Trade Organization.† The Codex is also used by nongovernmental organizations, food business operators, consumers, and standardization and certification organizations. Three Codex documents are basic to FcFV.

The “Recommended International Code of Practice—General Principles of Food Hygiene” is the basic document on food hygiene law for the whole world. It was published in 1969 and is known as the General Principles of Food Hygiene.‡ The CAC presents and recommends in the same document a HACCP-based approach for the entire food production chain as a means to enhance food safety.§

The more specific CAC “Code of Hygienic Practice for Fresh Fruits and Vegetables” was published in 2003. It has an “Annex for Ready-to-eat Fresh Pre-cut Fruits and Vegetables.”

The three Codex documents are cumulative.¶ The “Code of Hygienic Practice for Fresh Fruits and Vegetables” accepts the “General Principles of Food Hygiene” and adds the specific rules for the fresh fruits and vegetables. The “Annex for Ready-to-eat Fresh Pre-cut Fruits and Vegetables” in its turn accepts the “General Principles” and the “Code of Hygienic Practice” and adds the specifics for fresh-cut produce. Table 2.1 presents an overview of the three basic Codex Alimentarius law documents for FcFV.

There are many other Codex documents on specific aspects of fruits and vegetables. The “Recommended International Code of Practice for Packaging and Transport of Fresh Fruit and Vegetables” was made in 1995 for tropical fresh fruit

* U.S. Department of Health and Human Services, Food and Drug Administration and Center for Food Safety and Applied Nutrition, Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards of Fresh-cut Fruits and Vegetables, February 2008. <http://www.cfsan.fda.gov/~dms/prodgui4.html>.

† Bernd van der Meulen and Menno van der Velde, *European Food Law Handbook*, Wageningen 2008, pp. 468–472.

‡ Codex Alimentarius Commission CAC/RCP 1-1969, Rev. 4-2003 Recommended International Code of Practice—General Principles of Food Hygiene including Annex on Hazard Analysis and Critical Control Point (HACCP) system and Guidelines for its Application. The Code was adopted by the Codex Alimentarius Commission in 1969, revision 4 made in 2003 is the latest revision to date, http://www.codexalimentarius.net/web/more_info.jsp?id_sta=23.

§ Codex Alimentarius Commission CAC/RCP 1-1969, Rev. 4-2003, p. 3.

¶ CAC/RCP 53-2003, 2.2 Use, see note 6 supra.

TABLE 2.1
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
Section I Objectives	Introduction	Introduction
1.1 The Codex General Principles of Food Hygiene	1. Objectives of the Code	1. Objective
Section II Scope, Use, and Definition	2. Scope, Use, and Definitions	2. Scope, Use, and Definitions
2.1 Scope	2.1 Scope	2.1 Scope
2.1.1 The food chain		
2.1.2 Roles of governments, industry, and consumers		
2.2 Use	2.2 Use	2.2 Use
2.3 Definitions	2.3 Definitions	2.3 Definitions
Section III Primary Production	3. Primary Production	3. Primary Production
3.1 Environmental Hygiene	3.1 Environmental Hygiene	
3.2 Hygienic Production of Food Sources	3.2 Hygienic Primary Production of Fresh Fruits and Vegetables	
	3.2.1 Agricultural input requirements	
	3.2.1.1 Water for primary production	
	3.2.1.1.1 Water for irrigation and harvesting	
	3.2.1.1.2 Water for fertilizers, pest control, and other agricultural chemicals	
	3.2.1.1.3 Hydroponic water	
	3.2.1.2 Manure, biosolids, and other natural fertilizers	
	3.2.1.3 Soil	
	3.2.1.4 Agricultural chemicals	
	3.2.1.5 Biological control	
	3.2.2 Indoor facilities associated with growing and harvesting	
	3.2.2.1 Location, design, and layout	
	3.2.2.2 Water supply	
	3.2.2.3 Drainage and waste disposal	

TABLE 2.1 (Continued)
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
	3.2.3 Personnel health, hygiene, and sanitary facilities	
	3.2.3.1 Personnel hygiene and sanitary facilities	
	3.2.3.2 Health status	
	3.2.3.3 Personal cleanliness	
	3.2.3.4 Personal behavior	
	3.2.4 Equipment associated with growing and harvesting	
3.3 Handling, Storage, and Transport	3.3 Handling, Storage, and Transport	
	3.3.1 Prevention of cross- contamination	
	3.3.2 Storage and transport from the field to the packing facility	
3.4 Cleaning, Maintenance, and Personnel Hygiene at Primary Production	3.4 Cleaning, Maintenance, and Sanitation	
	3.4.1 Cleaning programs	
	3.4.2 Cleaning procedures and methods	
	3.4.3 Pest control systems	
	3.4.4 Waste management	
Section IV Establishment: Design and Facilities	4. Packing Establishment: Design and Facilities	4. Establishment: Design and Facilities
4.1 Location		
4.1.1 Establishments		
4.1.2 Equipment		
4.2 Premises and Rooms		
4.2.1 Design and layout permit Good Hygiene Practices (GHPs), protection against cross-contamination		
4.2.2 Internal structures and fittings		
4.2.3 Temporary /mobile premises and vending machines		
4.3 Equipment		
4.3.1 General		

TABLE 2.1 (Continued)
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
4.3.2 Food control and monitoring equipment		
4.3.3 Containers for waste and inedible substances		4.4 Facilities
4.4 Facilities		
4.4.1 Water supply		
4.4.2 Drainage and waste disposal	3.2.2.3 Drainage and waste disposal	4.4.2 Drainage and waste disposal
4.4.3 Cleaning		
4.4.4 Personnel hygiene facilities and toilets	3.2.3.1 Personnel hygiene and sanitary facilities	
4.4.5 Temperature control		
4.4.6 Air quality and ventilation		
4.4.7 Lighting		
4.4.8 Storage		
Section V Control of Operation	5. Control of Operation	5. Control of Operation
5.1 Control of Food Hazards Food business operators should control food hazards using systems such as Hazard Analysis and Critical Control Point (HACCP); Identify operation steps critical to food safety; Implement effective control procedures at those steps; Monitor control procedures to ensure effectiveness; Review control procedures periodically.	5.1 Control of Food Hazards	5.1 Control of Food Hazards Suppliers (growers, harvesters, packers and distributors) have to minimize contamination of the raw material and adopt CAC/RCP 53-2003. Certain pathogens, <i>Listeria monocytogenes</i> and <i>Clostridium botulinum</i> present specific food safety problems
5.2 Key Aspects of Hygiene Control Systems	5.2 Key Aspects of Hygiene Control Systems	5.2 Key Aspects of Control Systems
5.2.1 Time and temperature control	5.2.1 Time and temperature control	
5.2.2 Specific process steps Chilling Thermal processing Irradiation Drying Chemical preservation	5.2.2 Specific process steps 5.2.2.1 Postharvest water use 5.2.2.2 Chemical treatments 5.2.2.3 Cooling of fresh fruits and vegetables	5.2.2 Specific process steps 5.2.2.1 Receipt and inspection of raw materials 5.2.2.2 Preparation of raw material before processing

TABLE 2.1 (Continued)
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
5.2.2 Specific process steps (Continued) Vacuum or modified atmospheric packaging	5.2.2.4 Cold storage	5.2.2.3 Washing and microbiological decontamination 5.2.2.4 Precooling fresh fruits and vegetables 5.2.2.5 Cutting, slicing, shredding, and similar precut processes 5.2.2.6 Washing after cutting, slicing, shredding, and similar precut processes 5.2.2.7 Cold storage
5.2.3 Microbiological and other specifications	5.2.3 Microbiological and other specifications	
5.2.4 Microbial cross- contamination	5.2.4 Microbial cross- contamination	
5.2.5 Physical and chemical contamination	5.2.5 Physical and chemical contamination	
5.3 Incoming Material Requirements	5.3 Incoming Material Requirements	
5.4 Packaging	5.4 Packaging	
5.5 Water	5.5 Water Used in the Packing Establishment	
5.5.1 In contact with food		
5.5.2 As an ingredient		
5.5.3 Ice and steam		
5.6 Management and Supervision	5.6 Management and Supervision	
5.7 Documentation and Records	5.7 Documentation and Records In addition, keep current all information, keep records of processing much longer than shelf life Growers: production site, suppliers' information, use and lot numbers of agricultural inputs, irrigation practices, water quality data, pest control, cleaning schedules	5.7 Documentation and Records

TABLE 2.1 (Continued)
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
5.7 Documentation and Records (continued)	Packers: each lot, incoming materials, information from growers, lot numbers, data on quality processing water, pest control programs, cooling and storage temperatures, chemicals used in postharvest treatments, cleaning schedules	5.7 Documentation and Records
5.8 Recall Procedures	5.8 Recall Procedures In addition: keep information to trace products from the distributor to the field.	5.8 Recall Procedures

**Section VI Establishment:
Maintenance and Sanitation**

- 6.1 Maintenance and Cleaning
 - 6.1.1 General
 - 6.1.2 Cleaning procedures and
methods
- 6.2 Cleaning Programs
- 6.3 Pest Control Systems
 - 6.3.1 General
 - 6.3.2 Preventing access
 - 6.3.3 Harborage
 - 6.3.4 Monitoring and detection
 - 6.3.5 Eradication
- 6.4 Waste Management
- 6.5 Monitoring Effectiveness

**Section VII Establishment:
Personal Hygiene**

- 7.1 Health Status
- 7.2 Illness and Injuries
- 7.3 Personal Cleanliness
- 7.4 Personal Behavior
- 7.5 Visitors

Section VIII Transportation

- 8.1 General
- 8.2 Requirements
- 8.3 Use and Maintenance

TABLE 2.1 (Continued)
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
Section IX Product Information and Consumer Awareness		
9.1 Lot Identification		
9.2 Product Information		
9.3 Labeling		
9.4 Consumer Education		
Section X Training	10 Training	10 Training
10.1 Awareness and Responsibilities	Personnel for growing and harvesting must know the Good Agricultural Practices (GAPs), GHPs, their role and responsibility in hygiene. Knowledge and skills for agricultural activities and handling fresh fruits and vegetables (FFV)	Refer to CAC/RCP 1-1969 Rev 4 2003 and to CAC/RCP 53-2003
	Personnel for packing know Good Manufacturing Practices (GMPs), GHPs. Knowledge and skills to handle FFV and minimize microbial, chemical, and physical contamination	Required level of training
	Personnel handling cleaning chemicals or other potentially hazardous chemicals: instructed in safe handling	Packaging systems used for FFV with risks of contamination or microbiological growth
	Aware of their role and responsibility	Importance of temperature control and GMPs
10.2 Training Programs	10.2 Training Programs	10.2 Training Programs
Nature of the food, ability to sustain growth of pathogenic or spoilage microorganisms	Nature of the food, ability to sustain growth of pathogenic microorganisms.	Additional:
Manner of handling and packaging, with contamination probability	Agricultural techniques and inputs and the associated probability of microbial, chemical, and physical contamination.	The packaging systems used for fresh precut fruits and vegetables, including the risks of contamination or microbiological growth involved with this method;

TABLE 2.1 (Continued)
The Codex Alimentarius Law for Fresh-Cut Fruits and Vegetables

CAC/RCP 1-1969, Rev. 4-2003 General Principles of Food Hygiene	CAC/RCP 53-2003 Code of Hygienic Practice for Fresh Fruits and Vegetables	CAC/RCP 53-2003 Annex for Ready-to-Eat Fresh Precut Fruits and Vegetables
Extent and nature of processing or further preparation before final consumption	Task with hazards and controls.	The importance of temperature control and GMPs
Storage conditions	Processing and packaging manners for FFV.	
Expected length of time before consumption	Extent and nature of processing or further preparation by consumer.	
	Importance of good health and hygiene for personal health and food safety.	
	Importance of hand washing and hand-washing techniques.	
	Importance of using sanitary facilities to reduce contaminating fields, produce, other workers, and water supplies.	
	Techniques for hygienic handling and storage of FFV by transporters, distributors, storage handlers, and consumer.	
10.3 Instruction and Supervision		
10.4 Refresher Training		

and vegetables. The scope of this Code of Practice was enlarged to packaging and transport of all fresh fruits and vegetables by an amendment in 2004 that eliminated the word “tropical” from the title and where appropriate from the text.*

There are hundreds of national and international agrarian or marketing quality standards for individual fresh fruits and vegetables sold as whole fresh produce.

2.2.2 GOOD PRACTICES

Good practices are developed by active and knowledgeable persons and organizations with no government power or authority to introduce these practices. They have

* CAC/RCP 44-1995, AMD. 1-2004, Recommended International Code of Practice for Packaging and Transport of Fresh Fruit and Vegetables, http://www.codexalimentarius.net/web/more_info.jsp?id_sta=322.

to rely on the force of reason and proven success to convince others that a particular good practice is a valuable instrument for specific objectives.

Several organizations promote these good practices. When an international organization like the CAC goes beyond mere promotion and invests in lengthy negotiations to produce recommended practices, something is added to the good practice as it stood before the CAC published its nonbinding instrument. For one, dozens of government representatives have contributed to the discussions about the right formulation of the text. This process involves many consultations in the member states when stakeholders and other interested persons and organizations are asked to contribute ideas to determine the positions that the national representative will take.*

Reworking a nonbinding good practice into a nonbinding Codex document seemingly has little legal relevance. But governments change the legal character of the Codex Alimentarius recommendations and the good practices when they participate in CAC decision making. This is reinforced by explicit statements in their own legislation that they will contribute to the construction of international food law and will take this law into consideration when they make their own legislation. The EC is an example: it became a member of the CAC in 2003 and refers to the Codex at several places in its extensive collection of food regulations.†

2.2.3 DIFFERENT TYPES OF GOOD PRACTICES

Good practices are made by all kinds of organizations for activities in the food production chain. Some of these practices are made for particular stages of the food production chain in the way that a GAP will be followed by a GMP, and other practices for packaging and transport may be made corresponding to the CAC recommended international Codes of Practice.

2.2.4 THE CODEX GENERAL PRINCIPLES OF FOOD HYGIENE

The General Principles of Food Hygiene deal with all aspects of food hygiene in ten sections. These are presented with their subject matter in Table 2.1. The additional rules for fresh fruits and vegetables and for fresh-cut fruits and vegetables are also indicated.

Sections III to IX follow the food chain from primary production to the consumer. Section III begins with the selection of a suitable site for food production. Environmental hygiene and public health require that harmful substances from the environment cannot become part of the food in unacceptable levels. Production of

* See the U.S. Federal Register with prescribed information on Codex activities at http://www.fsis.usda.gov/Codex_Alimentarius/Related_Federal_Register_Notices/index.asp. See also the Food Safety Inspection Service that organizes public meetings with U.S. Delegates to Codex committees before their committee meetings to inform the public about the meeting agenda and proposed U.S. positions on the issues, http://www.fsis.usda.gov/codex_alimentarius/public_meetings/index.asp.

† Article 13 on international standards in Regulation (EC) No. 178/2002; Recital (18) in Regulation (EC) No. 852/2004: "This Regulation takes account of international obligations laid down in the WTO Sanitary and Phytosanitary Agreement and the international food safety standards contained in the Codex Alimentarius." See Bernd van der Meulen and Menno van der Velde, *European Food Law Handbook*, Wageningen 2008, pp. 467–482.

food can take place only where there are no such substances or when changes can be made that will prevent this contamination.

The hygienic production of food requires that the practices of primary production do not contaminate the food. Producers have to test the way they operate to identify the most likely activities or circumstances where contamination can occur and take measures to prevent contamination or reduce it to acceptable levels. The HACCP system is recommended as a method for this work. Producers are to take measures to

Control contaminations from air, soil, water, feedstuffs, fertilizers (including natural fertilizers), pesticides, veterinary drugs or any other agent used in primary production; control plant and animal health so that it does not pose a threat to human health through food consumption, (...) and protect food sources from faecal and other contamination.*

The rules on handling, storage, and transport as part of primary production call for sorting the harvested material to reject the parts that are unfit for food. The rejected material must be disposed of hygienically, and the food has to be protected from the negative influences of pests, and chemical, physical, and microbiological contaminants.†

Section IV Establishment: Design and Facilities deals with the infrastructure, location, and buildings where food is processed after the primary stage. These establishments must be suited to good food hygiene practices.

Section V Control of Operation deals with food hazards. It recommends to use a HACCP system, and deals with time and temperature and specific process steps under the heading “Key Aspects of Hygiene Control Systems.”

Section VI addresses the maintenance and sanitation of the establishment.

Personnel and personal hygiene are important items of several sections. Facilities have to be present for any necessary cleaning and maintenance and for personal hygiene in the primary production phase.‡ In any building or area where food is handled, facilities like an adequate supply of potable water, drainage, and waste disposal systems have to be present.§

Personnel hygiene requires that the management of the establishment provides the means needed for hygienically washing and drying hands, for lavatories, and for changing rooms.¶ Personal hygiene is one of the subjects of Section VII as part of a set of rules on the consequences of illness and injuries, personal cleanliness, and behavior. Persons who suffer from, or are carriers of, an illness that can be transmitted through food have to be prevented from contaminating it. The symptoms have to be recognized as early as possible. It is the responsibility of the inflicted person to

* CAC/RCP 1-1969, Rev. 4-2003, Section III Primary production, 3.2 Hygienic production of food sources.

† CAC/RCP 1-1969, Rev. 4-2003, Section III Primary production, 3.3 Handling, storage and transport.

‡ CAC/RCP 1-1969, Rev. 4-2003, Section III Primary production, 3.4 Cleaning, maintenance and personnel hygiene at primary production.

§ CAC/RCP 1-1969, Rev. 4-2003, Section IV Establishment: Design and Facilities, 4.4 Facilities, 4.4.1 Water supply; 4.4.2 Drainage and waste disposal; 4.4.3 Cleaning.

¶ CAC/RCP 1-1969, Rev. 4-2003, Section IV Establishment: Design and Facilities, 4.4.4 Personnel hygiene facilities and toilets.