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FRESH CUT FRUITS - AN OVERVIEW OF MICROBIOLOGICAL CONDITIONS, RECENT OUTBREAKS AND PREVENTIVE STRATEGIES

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ABSTRACT

Fruits play an essential role in the human diet, being the major source of dietary nutrients and preventing many chronic diseases. Nowadays, consuming prepared food is commonly preferred by consumers since they are time saving and more convenient. Within this scope, the fresh-cut market, mainly including fruits and vegetables, has broadened substantially in recent years. Fruits, which have a suitable environment for the growth of microorganisms, are also highly perishable products with a short shelf life because of mechanical operations. Therefore, serving the product as fresh-cut produce increases concern about the safety of these products, which has become another issue that the suppliers must consider. Recently, consumers have become more conscious of food safety since the transmission of pathogens can cause foodborne diseases. Therefore, information on fresh-cut fruits (FCFs) and recent outbreaks caused by these products are reported in this review. Data collected for each outbreak included the implicated food, year, pathogen, location, and number of cases. According to data, five outbreaks caused by FCFs were reported in recent years, resulting in 466 illnesses, 167 hospitalizations and 1 death. Mainly *Salmonella* spp. was found a common threat for the minimally produced fruits in these outbreaks. Preventive approaches were also included in the review to maintain the safety of FCFs.

Keywords: Outbreaks; Foodborne disease; Fresh cut fruits; Pathogens; *Salmonella* spp.

INTRODUCTION

Recently, the fresh produce market has grown substantially with the new lifestyle of consumers, defined as 'rich in cash/poor in time' and the demands for fresh and healthier ready-to eat foods (**De Corato, 2020; Olmez, 2016**). Fresh fruits are well recognized as important parts of a healthy diet in the World. International Fresh-Cut Produce Association (IFPA) defines fresh cut products as any fresh fruit or vegetable or a combination thereof that has been physically altered from its original form but remains in a fresh state since they have been trimmed, peeled and/or cut into an entirely usable product and then has been packaged to be served in markets or restaurants to offer consumers higher nutritional-value and flavor, freshness and economic convenience (**Jideani *et al*., 2017**; **Oliveira *et al*., 2015**). It means that fresh-cut fruits (FCFs) that are consumed without cooking or reheating (i.e., melon, pineapple, apple, strawberries, cantaloupes, watermelon, mango, papaya, and grapes) have become a popular food group thanks to their ease of preparation.
Since FCFs are fresh and contain essential vitamins, minerals, dietary fiber, and beneficial phytochemicals, consumer demand for FCFs in the World has steadily increased by 5% in recent years (**Feng *et al*., 2017**). These unique properties make FCFs important in daily diet. Furthermore, FCFs that have a significant role in the human diet are recognized by consumers as natural foods since they are prepared without added chemicals (**Alegre *et al*., 2013**; **More *et al*., 2019**). They also protect from various chronic diseases such as cardiovascular diseases and cancer. The favorable effects on human health resulting from the consumption of FCFs are associated with anthocyanins and other phenolic compounds with antioxidant and free radical scavenging properties, carotenoids, tocopherols and ascorbic acid they contain (**Gupta and Prakash, 2019**; **Oliveira *et al*., 2015**; **Qadri *et al*., 2015**). Hence, it has been stated that consuming fruit 4–5 servings/day can reduce the risk of such diseases (**More *et al*., 2019**). On the other hand, it is to provide longer shelf life for FCFs since they do not contain any preservatives and have a shorter shelf life of 4–10 days compared to the whole fresh fruit. Also, FCFs differ significantly in their biochemical and physiological properties compared to the unprocessed form due to wounding or minimal-processing procedures (cutting, shredding, peeling etc.). The processes performed during FCF production destroy the viable cells, increase pH and release significant quantities of liquid that contain utilized nutrients, and these provide a suitable medium for microbial growth.
Moreover, these products are not subjected to any killing steps such as pasteurization that would destroy pathogens. Therefore, FCFs deteriorate rapidly due to microbial contamination. If the initial count of microorganisms is high, some microorganisms will continue to grow and can play a significant role in the occurrence of foodborne diseases that may even, in some instances, lead to death (**Kabelitz and Hassenberg, 2018**). Consequently, it can be said that there is a correlation between the initial microbial population and microbiological quality of the final product and that FCFs are a carrier for the foodborne diseases despite having benefits.
According to the latest report of the Centers for Disease Control and Prevention (CDC), annually, 48 million people get sick because of consuming contaminated foods, 128,000 people were hospitalized and 3000 died from foodborne diseases (**Ali *et al*., 2019**; **CDC, 2017**). Outbreaks caused by pathogens can occur from very small events involving only a few people, or larger events that can affect several thousand people. However, it is estimated that most of the cases are dramatically under-reported (**Ali *et al*., 2019**). In recent years, the number of foodborne outbreaks associated with the consumption of fresh fruit products has been increased since there is a risk of microbial contamination of fruits from soil, irrigation water, organic fertilizers, harvesting, processing and packaging (**Scollard *et al*., 2016**). Therefore, FCFs consumed raw after minimal processing should not be considered as low-risk foods since they are susceptible to pathogen contamination for all steps from harvesting to processing (**Olmez, 2016**). The main reason for the emergence of foodborne diseases is the cross-contamination during pre and postharvest stages of food production, such as cultivation or preparation and processing of these foods (**Chukwu *et al*., 2010**). The postharvest factors including pre-treatments, transportation and distribution, processing and packaging, and storage, further influence the overall quality and safety. Thus, postharvest handling of products has an important role in controlling metabolic activities and maintaining food quality and safety.
In this review, after giving information on FCFs, preparation steps and microbiological risks, foodborne outbreaks caused by FCFs submitted to the Centers for Disease Control and Prevention (CDC), European Centre for Disease Prevention and Control (ECDC) and Washington State Department of Health (WSDOH) in recent years and preventive approaches to maintain safety of FCFs were summarized. Information from CDC, ECDC and also WSDOH about outbreaks in recent years were provided as the infected food, year of the outbreak, related pathogen, region of outbreak and number of reported cases, respectively. It is expected that this report containing up-to-date outbreak data will contribute to identifying factors leading to foodborne illnesses associated with FCFs and finding appropriate measures to prevent outbreaks in the future.

Production steps of FCFs

In FCF production, different steps are applied, and figure 1 shows an example of the basic flow diagram for producing FCFs. Firstly, fruits are harvested, sent to the factory and are pre-stored at low temperature for 12–24 h, then the peeling, trimming, deseeding, cutting and sorting processes are applied. Cleaning and disinfection of fresh fruits before the peeling, cutting etc., processes is important in terms of removing dirt and microorganisms that cause spoilage. Although it is thought that any contamination acquired in the field can be easily removed by washing, it is stated that in reality, a commercial washing process can provide only about 1-2 log cfu reduction. Thus, sanitizing operations and packaging or bagging under semipermeable cups are applied as final steps to extend shelf life and prevent foodborne illnesses. Afterwards, fresh cut fruit cups are reached to retails and stored under refrigerated temperature (between 2°C and 6°C) to slow microbial growth (**Corbo *et al*., 2010**). Temperature control is the most critical parameter for preserving the quality and extending the shelf life of the product. FCFs are susceptible to the growth of microorganisms since temperature change frequently occurs during fresh-cut-product storage, transportation, distribution. Also, retail display and production steps do not guarantee the total elimination of microorganisms from FCFs (**Alegre *et al*., 2013** In addition to this, product storage at low temperatures creates a weak barrier against the growth of psychrotrophic pathogens such as *Listeria monocytogenes*, while mesophilic pathogens such as *Salmonella* spp. and *Escherichia coli* O157:H7 are unable to grow where temperature control is adequate (i.e., ≤ 4°C). In a study performed by **Nyarko *et al*. (2016)**, the growth of *L. monocytogenes* on fresh-cut cantaloupe during refrigerated storage was examined and it has been found that the growth of *L. monocytogenes* is promoted when FCFs were kept at 10°C or exposed to temperature-abused events (for 4 h at 25°C). In another study performed by **Huang *et al*. (2019)**, it was reported that the *Salmonella enterica* count remained the same while *L. monocytogenes* grew consistently during the 7 days at 4°C.

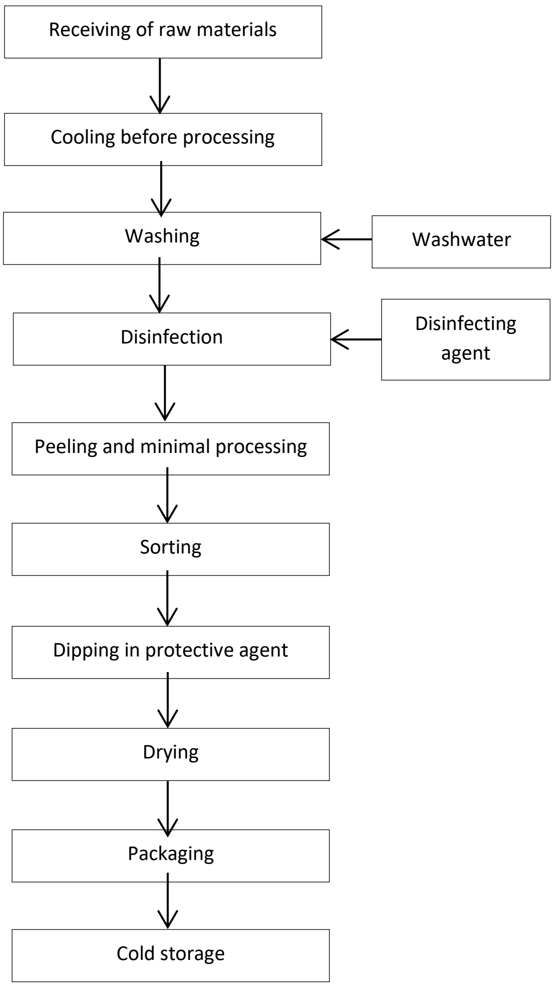

Figure 1 General fresh cutting process flow chart for fruits and vegetables (adapted from **Corbo *et al*., 2010**)

Every step of FCF production, from harvest to table, is vital for the safety and quality of the produce. In the production of FCFs, quality and safety properties can be multifaceted depending on methods and/or technologies used (**Baselice *et al*., 2017**). It is claimed that processing of products causes a faster physiological deterioration such as degradation of color, texture, and flavor of the product, ethylene production, increase in respiration rate, decrease in acidity, biochemical changes, and microbial spoilage even though the processes applied are minor (**Qadri *et al*., 2015**). Although some properties remain the same, others such as pH, water activity and microflora of the product change mostly after processing fresh fruits (**Oluk, 2018**). According to researches, FCFs contain similar nutrients and ingredients like whole products, in addition to the advantage of easy and short time preparation (**Jideani *et al*., 2017**). However, some operations such as peeling and cutting, which leads to a high humidity condition and increased surface area, get more perishable, susceptible to physical, enzymatic and microbiological deterioration (**Gupta and Prakash, 2019**).

Various disinfectants are used in order to reduce bacterial population of FCFs during the production steps. Chlorine is known as the most widely used sanitizer for washing fruits since it is relatively cheap. However, studies have reported that standard chlorine concentrations (50-200 ppm) are not sufficient to completely reduce pathogens on fruits (**Oliveira *et al*., 2015**). Also, in some countries, sanitizers are not allowed in the fresh-cut industry (**Althaus *et al*., 2012**). In this context, there is exactly no killing step that can ensure the elimination of pathogenic bacteria during the production of these products. Also, the pre-cut fruits sold at various retail markets were found contaminated with bacteria (90.67%), although the foods seemed suitable for consumption. It was reported that these bacteria include *E. coli* (46.00%), *Staphylococcus aureus* (19.33%), *Salmonella* spp. (8.67%), *Proteus* spp. (12.00%), *Enterobacter aerogenes* (2.00%), *Klebsiella pneumoniae* (11.33%) and *Pseudomonas aeruginosa* (1.33%) (**Chukwu *et al*., 2010**). Consequently, foodborne illness outbreaks (e.g. salmonellosis, listeriosis) related to the consumption of contaminated FCFs occur, despite the good manufacturing practices (GMP) to ensure food safety (**Gupta and Prakash, 2019**). Foodborne illness is an important public health concern for developed and developing countries and thus, FCFs are increasingly the focus of food safety issues for producers, public and the regulatory agencies (**Wu *et al*., 2018**). In outbreaks, there are different type of factors which affect food safety such as growing demand to fresh-cut produce, higher consumption, aging population, and possible changes in climate conditions (**Tirado *et al*., 2010**).

Factors affecting microbial growth in FCFs

The pH value of the fruits affects the survival and growth of microorganisms. Generally, bacteria can grow at pH values between 4 and 9, whereas yeasts can grow easily at low pH values. On the other hand, molds can grow in the broadest range of pH conditions (**Singh e*t al.*, 2018**). Most of the fruits have low pH values, which is less than 4.0. Thus, they are not considered as a suitable medium for pathogen growth. However, some of them cannot be considered as high acidic fruits such as melons, cantaloupe, watermelon, cactus pears and coconut due to their pH value ranging between 5.2 and 6.9. Watermelon and melons, which can be considered low-acid foods, are preferred in minimally processed food cups. Besides, if pH gradient changes because of unexpected damages on surface tissue by insects or mechanical abuse, it provides suitable conditions for growth of pathogenic bacteria (**Corbo *et al*., 2010**). Processing and storage conditions can alter the pH value of the fruits due to high levels of CO_2. According to a study, the average pH value of fresh-cut pitaya, mango, papaya, honeydew melon, cantaloupe and watermelon was higher than 4, which is not enough to inhibit most of the pathogens, while the pH of fresh-cut pineapple was lower than 4 (**Feng *et al*., 2017**). The researchers concluded that the number of *Salmonella* spp. could reach higher than 7.0 log cfu/g, and it increased during storage time in every FCFs except for pineapple, where the growth of *Salmonella* spp. was decreased from 2.7 log cfu/g to 2.0 log cfu/g after 6 days.

Water activity (a_w) is also an important factor in food preservation and plays an important role in the growth of microorganisms and affects the quality of fresh-cut products (**Sandulachi, 2010**). Fruits continue respiration after the harvest by using stored available sugars and produce CO_2 and ethylene that cause rapid maturation. Cutting of fruits affects the a_w in addition to stress-induced ethylene production and water loss accelerates because of this case. Eventually, the microbial population can enhance (**Corbo *et al*., 2010**). Since fruits are cut into pieces, a_w value remains high and creates a suitable environment for the growth of pathogens after processing. **Feng *et al*. (2017)** reported that a_w values change between 0.93 and 0.98 after cutting fresh-cut honeydew, melon, cantaloupe, watermelon, pitaya, mango, and papaya pineapple.

Fresh fruits like apple, peach, orange and pineapple have a natural protective barrier, which protects them against most plant spoilage and pathogenic microorganisms as well as minimizing contact with soil or irrigation water. Besides, the population of indigenous microbiota of fruits having low pH might be lower than others (**Abadias *et al*., 2008**). However, this barrier can be damaged during the postharvest processing of FCFs. The conditions under which this processing occurs can significantly affect the quality of the end product (**Perni *et al*., 2008**) and also, they get susceptible to contamination (**Qadri *et al*., 2015**). Furthermore, without the covering layer, fruits become prone to physical damage which leads to spoilage and reduces the shelf life. In particular, cutting and slicing steps help pathogens to survive and grow since damaged surfaces provide nourishment for microorganisms and promote microbial growth (**Scollard *et al*., 2016**).

Besides, the importance of efficient temperature control from processing to consumption, including transportation, distribution, storage and handling, has been emphasized in the studies that examine the growth of foodborne pathogens and naturally occurring microbiota in FCFs stored at different temperatures. If the temperature of the environment is suitable, microorganisms can easily grow and cause spoilage in FCFs (**Colás-Medà *et al*., 2016; Feng *et al*., 2017**). Therefore, food producers, distributors and vendors need to ensure that all food safety requirements are met at all stages and that FCFs are stored at low temperatures to keep the safety and quality of the product (**Denis *et al*., 2016**). Besides, **Yi *et al.* (2020)** reported that applying only low temperature is not effective in controlling microorganisms found in FCFs. Thus, it can be said that temperature is a crucial point for avoiding microbial growth but at the same time, other factors must be taken into consideration as well, so that adjustments can be made accordingly.

Natural and contaminated microflora in FCFs

Contamination of fresh fruits with microorganisms may occur during pre-harvest (animals, insects, water, soil, air, dirty equipment and human handling) or postharvest (washing water, air, personals, packing materials, equipment and transportation vehicles). Among the main contamination sources that occur, there are contaminated seeds, irrigation water, animal manure, soil, fecal contamination, geographical location, and climate change (**Scollard *et al*., 2016**). Irrigation water is known as the main contamination source, because large number of fecal coliforms and pathogenic bacteria are transmitted to the fresh produce (**Olmez, 2016**).

Microflora of fruits may substantially differ depending on pH, nutrient availability, a_w, the fruit diversity, operations such as cutting, slicing etc. and packaging and storage conditions (**Graça *et al*., 2017**). Moreover, microorganisms' growth and survival on FCFs are affected by intrinsic (pH, nutrient content, water activity, oxidation reduction potential, biological structure and natural antimicrobial compounds) and extrinsic factors (temperature, moisture, oxygen requirements). Yeasts (*Cryptococcus, Rhodotorula* and *Saccharomyces* spp.) and molds (*Zygosaccharomyces rouxii*, *Hanseniaspora*, *Candida*, *Debaryomyces* and *Pichia* spp.) are the dominant microorganisms associated with the spoilage of FCFs. However, some fruits with a neutral pH, such as cantaloupe, watermelon, and melon, also have bacteria in their flora, and *Pseudomonas*, which causes spoilage, has been reported to be the predominant microorganism on fresh produce (**Beaulieu and Gorny, 2016; Corbo *et al*., 2010**). Also, lactic acid bacteria (LAB), especially *Lactobacillus* and *Leuconostoc*, causing spoilage are indigenous flora of fruits.

Table 1 Microbial population of FCFs

FCFs	Microbial Population (log cfu/g)					References
	TMAB	TPAB	Yeast and mold	LAB	Coliform	
Pineapple	-	3.7	4.4	-	-	Leneveu-Jenvrin *et al*., 2020
Pears	<1	-	<1	-	-	Chen *et al*., 2019
Pineapple	5.2-5.5	-	5.8-6.3	2.8-5.2	-	Neetoo *et al*., 2019
Watermelon, pineapple	5.6-7.3	-	2.3-6.3	-	2.6-5.2	Piano and Castillo-Israel, 2019
Apple	6.4	-	3.5 (yeast), 2.2 (mold)	-	-	Rux *et al*., 2019
Papaya, muskmelon and guava	4.95-5.28	-	-	-	-	Thakur *et al*., 2019
Pineapple, mango, papaya, green melon, cantaloupe melon, galia melon, watermelon, strawberries, fruit salads	3.0-9.2	2.2-10.7	2.3-10.4	1.9-9.0	1.0-9.1	Graça *et al*., 2017
Pineapple	1.63	ND	3.07	-	-	Treviño-Garza *et al*., 2017
Cantaloupe	2.82-4.05	-	2.88-3.71	-	-	Koh *et al*., 2016
Cantaloupe	3.88	-	-	-	-	Lopez *et al*., 2016
Salad pack	5.5	-	3.9	-	5.4	Sureshkumar *et al*., 2016
Kiwi fruit	3.15	-	2.46	-	-	Benítez *et al*., 2015
Apple	3.3-8.9	4.9-8.4	3.6-7.1	2.8-8.7	1.8-7.6	Graça *et al*., 2015
Fuji apple	-	5.5	5.2	-	-	Salvia-Trujillo *et al*., 2015
Pineapple	1.63	1.42	3.86	-	-	Mantilla *et al*., 2013
Pineapple	3.98–4.21	3.43–3.71	3.03–3.29	-	-	Wu *et al*., 2012
Fresh fruit salad	3.0	-	-	-	-	Costa *et al*., 2011
Apple, peach, orange, mango, pineapple	2.0-7.1	1.7-7.1	1.7-4.9	1.7-4.8	-	Abadias *et al*., 2008
Pineapple	-	-	3-4	-	-	Montero-Calderón *et al*., 2008
Fruit salad	-	-	2.0-9.72	-	-	Tournas *et al*., 2006
Guava, mango, melon, papaya, pineapple	-	-	1-8	-	0.4-6.3	Pinheiro *et al*., 2005
Pineapple, watermelon	6-8	-	-	-	4-7	Viswanathan and Kaur, 2001
Cantaloupe	1.05	-	-	-	-	Lamikanra *et al*., 2000

ND: Not detected

Studies examining the microbiological quality of FCFs indicate that the total count of mesophilic aerobic bacteria (TMAB), psychrotrophic aerobic bacteria (TPAB), and yeast-mold varies in the range of 2.0-9.2 log cfu/g, 1.7-10.7 log cfu/g, and 1.7-10.4 log cfu/g, respectively (Tab 1). The counts of TMAB and TPAB gives information about the quality and shelf life of the FCFs and psychrotrophs such as *L. monocytogenes* are a considerable problem for vendors since FCF products (especially apple and cantaloupe) are stored under refrigerated conditions to increase the shelf life (**Graça *et al*., 2017**). Also, the coliform count is considered as an indicator of fecal pollution, high level of coliform count generally shows poor hygiene practices during or after the production of FCFs. Accordingly, it is essential to determine the microbial load of FCFs to have information about the safety and quality of these products. On the other hand, the natural microflora plays an important role in controlling populations of pathogens, either by direct competition or through the production of antimicrobials (**Francis *et al*., 2012**).

As a result of epidemiological researches, it was concluded that various pathogenic microorganisms including bacteria (*Enterobacter*, *Shigella*, *Salmonella*, *E. coli* O157:H7, *Bacillus cereus*, *Campylobacter* spp., *L. monocytogenes, Yersinia enterocolitica*, *Clostridium botulinum*), viruses (Hepatitis A, Rotavirus and Norwalk virus), and parasites (*Giardia lamblia*, *Cyclospora cayetanensis* and *Cryptosporidium parvum*) could be found in fruits with a pH above 4 due to contact with soil during harvesting (**Corbo *et al*., 2010; Oliveira *et al*., 2015**). In particular, the biggest concern related to reported cases and severity of illness is bacteria since they have nutrients required to promote the growth of pathogenic and toxigenic microorganisms (**Olmez, 2016**). Many studies investigating the prevalence of foodborne pathogens in FCFs have identified the presence of *E. coli* (**Althaus *et al*., 2012; Chukwu *et al*., 2010; Denis *et al*., 2016; Sureshkumar *et al*., 2016**), *L. monocytogenes* (**Denis *et al*., 2016; Zhang *et al*., 2018**), *Staphylococcus aureus* (**Chukwu *et al*., 2010**), Shiga toxin–producing *E. coli*, enteropathogenic *E. coli, Cronobacter* (**Althaus *et al*., 2012**), *Enterobacter aerogenes* (**Chukwu *et al*., 2010**), *Proteus* spp. (**Chukwu *et al*., 2010**), *Klebsiella pneumonia* (**Chukwu *et al*., 2010**), *Pseudomonas aeruginosa* (**Chukwu *et al*., 2010**), *Shigella* spp. (**Denis *et al*., 2016**) and *Salmonella* (**Chukwu *et al*., 2010; Denis *et al*., 2016; Piano and Castillo-Israel, 2019; Sureshkumar *et al*., 2016; Zhang *et al*., 2018**).

As reported in the studies, one of the important contaminant pathogens in FCFs is *Salmonella* spp., an acid tolerant bacterium, which is known as a common cause of a foodborne illness, called salmonellosis. In addition, *L. monocytogenes* is a psychrotrophic bacteria that can grow both under ambient and refrigeration conditions in FCFs. It is widespread in soil and causes listeriosis. Researches showed that *L. monocytogenes* is found in pre-packaged FCFs such as tomatoes and cantaloupe (**Singh *et al*., 2018**). Another pathogenic microorganism related to illnesses is *C. botulinum*, which produces spores and is mostly found in agricultural soils and on the surfaces of fruits. *E. coli* O157:H7 is also a pathogen associated with produce-borne outbreaks (**Singh *et al*., 2018**). It is a life-threatening bacterium that can produce potent toxins that cause severe damage to the intestine lining. *E. coli* O157:H7 and *Salmonella* spp. contaminated fresh produce cause 42.9% and 34.3% of the outbreaks, respectively (**Feng *et al*., 2017**). Furthermore, *Shigella* spp., *Yersinia* spp., *Bacillus* spp. and *S. aureus* are also detected as pathogenic microorganisms causing foodborne illnesses in fresh products (**Olmez, 2016**). In addition to these, viruses such as Norwalk virus and hepatitis A virus cause foodborne diseases associated with minimally processed foods (**Chatziprodromidou *et al*., 2018; Zhou *et al*., 2017**). Pathogen contamination caused by hygiene deficiency can be easily transferred to FCFs from hands and products and products and food-contact surfaces (**Wang *et al*., 2013**). Thus, FCFs may contain various microorganisms including pathogens, that cause foodborne illnesses, despite not causing any loss in the apparent quality of the products.

Recent outbreaks associated with the consumption of FCFs

Recently, five reported outbreaks caused by FCFs resulted in 466 illnesses, 167 hospitalizations and 1 death (**CDC, 2018, 2019a, 2019b; ECDC, 2013; WSDOH, 2017**). *Salmonella* spp. (*Salmonella* Taviana, *Salmonella* Carrau, *Salmonella* Adelaide, *Salmonella* Newport) are found as common threat for these outbreaks (Tab 2). Normally, the natural reservoirs of *Salmonella*, which has over 2700 serotypes, are animals and birds. *Salmonella* is carried by both domesticated and wild animals and can contaminate irrigation or wash water directly or indirectly. Thus, the fruits are contaminated if soil and crops contact these materials (**Sengun and Karapinar, 2006**). Symptomatic infection caused by *Salmonella* is known as salmonellosis. Although salmonellosis is generally associated with the consumption of food of animal origin, it was determined that salmonellosis may also occur as a result of contaminated FCFs consumption (**Oliveira *et al*., 2015**). The reason for this issue is basically known as contamination of fresh produce. When the studies are examined, it can be seen that outbreaks of salmonellosis are mainly associated with the consumption of cut cantaloupe, watermelon, honeydew, pineapple, melon and grapes (Tab 2). Among these fruits, cut cantaloupe with low acidity (pH 5.2 to 6.7) and high- a_w (0.97 to 0.99) is particularly considered as a potentially hazardous food in FDA Food Code since it supports the growth of pathogens. Similarly, melons may naturally be contaminated with *Salmonella* spp. The microbial quality of FCFs is affected by the type of fruit, minimal processing operations, packaging, and storage conditions. For the preparation of FCFs, FDA recommends washing before cutting processes, using clean and sanitized utensils and keeping cut melons at or below 7°C (**Harris *et al*., 2003**) and cut melons should not be kept at room temperature longer than 4 hours if they are not refrigerated (**Bhagwat, 2005**). In addition, the cause of *Salmonella*-related outbreaks in FCFs is associated with the ability of *Salmonella* to internalize into products and proliferate to high numbers under favorable conditions (**Olmez, 2016**).

Table 2 The outbreaks associated with FCFs in recent years

FCFs	Illnesses onset date	Pathogen	States	Number of Cases			References
				Illnesses	Hospitalized	Dead	
Cantaloupe, honeydew, pineapple, grapes	November/2019	*S.* Javiana	14	165	73	-	CDC, 2019a
Melon, watermelon, honeydew, cantaloupe	March/2019	*S.* Carrau	10	137	38	-	CDC, 2019b
Melon	April/2018	*S.* Adelaide	8	77	36	-	CDC, 2018
Watermelon, cantaloupe	October/2017	*S.* Newport	2	24	6	1	WSDOH, 2017
Watermelon	October/2011	*S.* Newport	6	63	14	-	Byrne *et al*., 2014; ECDC, 2013

According to the CDC's database, Luau fruit mix as well as honeydew melon, cantaloupe, and pineapple products distributed between November 15 and December 1, 2019 have been collected back by Tailor Cut Produce on December 7, 2019, since there was potential contamination of these products with *Salmonella* Javiana. The products, which were not sold directly to consumers in the markets, were sent to institutional food service organizations such as hospitals, long-term care facilities, schools and hotels (**CDC, 2019a**). In collective consumption areas, many people are at risk of getting infected simultaneously, so recalled products should not be sold in these areas and should be collected urgently. It was reported that illnesses started between November 7, 2019 and January 11, 2020. Other than people lived in New Jersey, Delaware, New York and Pennsylvania, reported traveling to at least one of these 4 states in the week and proclaimed their illnesses. The median age of people who consumed these products was 44 years old, and 53% of ill people were female. Fifty-eight of sixty-two of them reported that they ate cut fruit served by Tailor Cut Produce Luau Mix in long-term care facilities, hospitals, hotels, schools, or at a university. In parallel with, CDC declared that Tailor Cut Produce was identified as the common processor while the source of contamination was not clearly identified.

Another report showed that the contamination source was pre-cut melon supplied by Caito Foods LLC of Indianapolis in multistate, including Minnesota, Wisconsin, Iowa, Michigan, Ohio, Alabama, Illinois, Indiana, Kentucky and Missouri. It was reported that illnesses started on the dates ranging from March 3, 2019 to May 1, 2019. The causative strain was detected as *Salmonella* Carrau and according to the reports, the pathogen caused an infection in 137 people with a median age of 53 and 63% of ill people were female. In order to clarify the source of infection was the same or not, laboratory studies had been performed to identify the causative pathogen by pulsed-field gel electrophoresis (PFGE) and whole genome sequencing (WGS), which showed that isolates from ill people were genetically close (**CDC, 2019b**). After this case, products were recalled by Caito Foods LLC on April 12, 2019. Since the contamination source was certain, it was indicated that the outbreak became appear on May 24, 2019.

Another outbreak published in 2018 was related with Caito Foods, LLC. It was reported that 77 people, with a median age of 67, became ill to consume *Salmonella* Adelaide contaminated pre-cut cantaloupe, watermelon or a fruit salad mix with melon, purchased from grocery stores. Between April 30 and July 2, 2018, it was reported that illnesses raised and also most of the ill people continued to eat the same products. After pre-cut melon was detected as the primary source of the infection (**CDC, 2018**), they were recalled from related places on June 8, 2018. It was indicated that the outbreak became appear on July 26, 2018.

In 2017, another foodborne disease caused by *Salmonella* Newport was reported by WSDOH (**WSDOH, 2017**). In this outbreak, 24 people (21 in Washington and 3 in Oregon) with a median age of 61 infected with *S.* Newport. It was indicated that illnesses, onset dates ranged from October 28, 2017 to December 6, 2017 and infected people purchased pre-cut watermelon and cantaloupe produced by Mary's Harvest Fresh Foods from grocery stores.

In 2011, an outbreak, associated with watermelon slices, contaminated with S. Newport, was reported in England, Wales, Northern Ireland, Scotland, Ireland, and Germany. It was reported that the watermelons had been supplied whole to a major UK processor, where they were sliced, packaged and distributed that caused the outbreak was imported from market in Brazil. Afterwards, isolates from patients and fruit samples were qualified and compared. Consequently, between 31 October 2011 and 31 January 2012, it was reported that there were 63 confirmed cases (**ECDC, 2013**).

As a consequence, there is a fluctuation in the number of infected people consuming contaminated FCFs between 2011 to 2019 according to reports. It is a fact that the outbreaks threaten not only human health but also affects the economy negatively (**Callejón *et al*., 2015**). Mostly, the outbreaks were multistate, known as outbreaks that either spread to other states or occur in multiple states at the same time caused by consuming the same food (**Purayidathil and Ibrahim, 2012**). *Salmonella* spp. was the main pathogen responsible for the multistate outbreaks. Most people infected with *Salmonella* experienced symptoms such as diarrhea, fever and stomach cramps after 12 to 72 hours. Also, experts specified that the illness usually occurs 4 to 7 days. As a result of performed studies on why *Salmonella* spp. causes outbreaks associated with FCFs consumption, it has been concluded that *Salmonella* spp. can replicate to relatively high levels on or within the plant and can contaminate fruits directly or indirectly (**Callejón *et al*., 2015**). However, if fresh-cut products are maintained below 7°C, *Salmonella* spp. do not grow in foods and not pose a risk in terms of causing foodborne diseases (**James *et al*., 2010**).

Preventive approaches to maintain safety of FCFs

Determination of contamination source and detection of pathogens are very important in order to prevent the risk related to the consumption of FCFs since they are consumed uncooked (**Corbo *et al.*, 2010**). Besides, another thing to consider during processing is the initial microbial load of fruits. If microbial load is high and/or the preparing operations are not hygienic enough, some pathogens can continue to survive and cause illness (**Santo *et al.*, 2016**). Thus, prevention and control of foodborne pathogens is important in fresh-cut produce and must begin in the field. After suitable harvesting, clean potable water must be used to irrigate the incoming fruits contacting with soil, mud or sand. The harvesting equipment should be thoroughly cleaned and sanitized to prevent contamination before further production. Also, after peeling or cutting, products should be washed again in order to remove microorganisms.

Most importantly, in all stages, Good Manufacturing Practice (GMP) and food safety systems such as Hazard Analysis and Critical Control Points (HACCP) must be applied to produce FCFs safely and workers should apply personal hygiene rules properly. In addition, for suitable production, retail display cases must be kept clean and at appropriate chilled temperatures. Finally, consumers should be informed as to proper hygienic handling of the products (**Olmez, 2016**).

It is stated that FCFs contaminated with foodborne pathogens such as *E. coli* O157:H7, *Salmonella* and *L. monocytogenes* cannot be completely decontaminated by current industrial sanitizing and washing processes during processing (**Abadias et al., 2012**). Therefore, researchers have carried out many studies on pathogen inhibition and inactivation to improve the safety of FCFs besides (Tab 3).

Table 3 Studies on prevention methods to ensure safety and quality of FCFs

FCFs	Target pathogens	Inoculum level	Preservation method	Results	References
Apple	*L. monocytogenes*	5.97 log cfu/ml	A bilayer probiotic edible coating	The bilayer probiotic edible coating was able to inhibit the proliferation of *L. monocytogenes* during the chilled storage.	Wong *et al*., 2021
Pear, apple and melon	*L. monocytogenes*	10^6 cfu/ml	Pomegranate peel extract	The extract at 12 g/l significantly reduced the bacterial load by 1.24, 1.89, and 0.91 log units soon after treatment and by 3.81, 1.53, and 2.99 log units, after 7 days of storage on apple, pear and melon, respectively.	Belgacem *et al*., 2020
Pitaya, pawpaw, kiwifruit, pineapple, cantaloupe, muskmelon	*L. monocytogenes, E. coli* and *Salmonella typhi*	10^6 cfu/ml	Bicontrol (metabolites of the *Lactobacillus pentosus* MS031)	*L. pentosus* metabolites could reduce 96.3% of *L. monocytogenes*, and to an undetectable level of *Salmonella* and *E. coli* during the storage period.	Yi *et al*., 2020
Apple	*L. monocytogenes, Salmonella* Typhimurium, *S. aureus, E. coli* O157:H7	10^8–10^9 cfu/ml	Thyme oil (TO) and alginate based coating	Edible coating (EC) containing high concentrations of TO resulted in high antibacterial activity against pathogens.	Hu *et al*., 2019
Pears	*Salmonella enterica, L. monocytogenes*	10^5 cfu/ml	Biocontrol (*Pseudomonas graminis* CPA-7)	1 log reduction in *L. monocytogenes* population and CPA-7 was not found to have antagonistic activity against *S. enterica*.	Iglesias *et al*., 2018
Papaya	*E. coli, L. monocytogenes, S. enterica*	10^5 cfu/g	Nut by-products (cashewnut shell, coconut shell, and peanut hull extracts)	Cashewnut shell and coconut hull extracts have potential to inhibite *E. coli, S. enterica* and *L. monocytogenes.*	Prakash *et al*., 2018
Melon (Cultivars of Galia, Piel de sapo and Cantaloupe)	*L. monocytogenes, S.* Enterica and *E. coli* O157:H7	10^5 cfu/ml	Biocontrol (*P. graminis* CPA-7)	In 'Galia' melon, co-inoculation of *L. monocytogenes* with CPA-7 resulted in a reduction of the pathogen's growth by 2.4 and 3.8 log-units, in 'Piel de sapo' melon, co-inoculation with CPA-7 did not result in a significant reduction of *L. monocytogenes* populations and, *L. monocytogenes* growth declined by 1.8 log-units when co-inoculated with CPA-7 in 'Cantaloupe' melon.	Collazo *et al*., 2017
Pears	*Salmonella* spp., *L. monocytogenes*	10^5 cfu/ml	Biopreservation (*Lactobacillus L. rhamnosus* GG and *Lactobacillus acidophilus* LA-5)	*L. acidophilus* LA-5 did not shown any effect against pathogens. *L. rhamnosus* GG was reduced *Salmonella* and *L. monocytogenes* population by 2 log and 3 log units, respectively.	Iglesias *et al*., 2017
Pineapple	*L. monocytogenes* and *S. typhi*	10^8 cfu/ml	Layer by layer edible coatings (ECs) (chitosan, pullulan, linseed, nopal cactus and mucilages)	Chitosan and pullulan ECs reduced the growth of *L. monocytogenes* and *S. typhi.*	Treviño-Garza *et al*., 2017
Strawberry	Hepatitis A virus (HAV), murine norovirus (MNV-1), MS2 bacteriophage, *E. coli* O157:H7, *L. monocytogenes*, *S.*Typhimurium, *Enterococcus faecium*, *E. coli* P1	10^4 pfu/g for HAV and MNV-1; 10^7 pfu/g for MS2 and ca; 10^{6-7} cfu/g for pathogens	Levulinic acid (LVA) and with sodium dodecyl sulfate (SDS)	LVA (0.5%) plus SDS (0.5%) wash reduced the numbers of HAV, MNV-1, MS2 by 2.7, 1.4 and 2.4 log, respectively, and reduced *E. faecium*, *L. monocytogenes* and *Salmonella* populations by over 2.0 log, while the numbers of *E. coli* O157:H7 and *E. coli* P1 reduced by 1.9 and 1.8 log cfu/ml.	Zhou *et al*., 2017
Persimmon	*E. coli, S. enteritidis and L. monocytogenes*	6 log cfu/ml	Pectin-based edible coating (EC) and low oxygen modified atmosphere packaging (MAP)	The application of the pectin antimicrobial coating significantly reduced the *E. coli* and *L. monocytogenes* count by 1.5 and 1.0 log units respectively, whereas *S. enteritidis* was reduced by more than 2.0 log units.	Sanchís *et al*., 2016
Apple, melon, pear	*Cronobacter sakazakii*	10^7 cfu/ml	UV-C and electrolyzed water	UV-C 7.5 and 10 kJ/m^2 reduced *C. sakazakii* population by 2–2.4 log cfu/g.	Santo *et al*., 2016

Table 3 (*Continued*)

FCFs	Target pathogens	Inoculum level	Preservation method	Results	References
Cantaloupe melon, pineapple	*L. monocytogenes*	10^2 cfu/g	Thyme essential oil (TEO) and EO compounds camphor and verbenone with MAP and air	TEO demonstrated the best anti-listerial effect, camphor showed no anti-listerial effects and verbenone was found to have anti-listerial properties.	Scollard *et al*., 2016
Dragon fruit	*E. coli, Salmonella typhimurium, and L. monocytogenes*	10^6 cfu/ml	Green tea extract with atmospheric radio frequency (ARF) plasma	Combined use of ARF plasma at 40 W and 5.0% of green tea reduced the pathogen counts by about 5-6 log cfu/g.	Matan *et al*., 2015
Avocado, watermelon	*Listeria innocua, E. coli*	10^8 cfu/ml	Malic acid dip or pulsed light and combination of both	More than 5 log reductions in *L. innocua* and *E. coli* counts was achieved by combined treatments.	Ramos-Villarroel *et al*., 2015
Fuji apple	*E. coli*	10^8-10^9 cfu/ml	Nanoemulsion based EC with lemongrass EO (LEO)	When the samples coated with solutions containing 0.5% or 1% (v/v) of LEO, the *E. coli* counts reduced up to undetectable levels (2 log units).	Salvia-Trujillo *et al*., 2015
Melon, pear and apple	*L. monocytogenes*	10^5 cfu/ml	Bacteriophage	Phage treatment was more effective on melon followed by pear and reduced *L. monocytogenes* count by 1.50 and 1.00 log cfu/plug for melon and pear slices, respectively while no effect on apple products was observed.	Oliveira *et al*., 2014
Pineapple	*L. monocytogenes, E. coli* O157:H7	2x10^7-2x10^8 cfu/ml	Biocontrol (*L. plantarum* *L. fermentum)*	*L. plantarum* was able to inhibit the growth of both pathogens, while *L. fermentum* was effective only against *L. monocytogenes*	Russo *et al*., 2014
Mango	*L. monocytogenes*	1 x10^7 cfu/g	Nisin-incorporated cellulose films	The count of *L. monocytogenes* was reduced below the detection level after 4 days in samples packed with nisin-incorporated cellulose films.	Barbosa *et al*., 2013
Apple	*E. coli O157:H7, L. monocytogenes* and *S.* Typhimurium	5.76, 6.29 and 6.08 log cfu/ml	Calcium oxide (CaO), sonication, and their combination	The population of *E. coli* O157:H7, *L. monocytogenes* and *S.* Typhimurium inoculated on apple slices was reduced by 1.45, 2.67 and 2.23 log10 cfu/g with the sonication application. Moreover, the combination with CaO and sonication inhibited the pathogens more effectively.	Yoon *et al*., 2013
Apple	*Salmonella* and *L. monocytogenes*	1 x10^5 cfu/ml	Biopreservation (*Lactobacillus rhamnosus* GG)	*Salmonella* was not affected by co-inoculation with *L. rhamnosus* GG, but *L. monocytogenes* population was 1-log units lower in the presence of *L. rhamnosus* GG.	Alegre *et al*., 2011
Apple	*E. coli, L. innocua, S. choleraesui*	1 x10^7 cfu/ml	Electrolyzed Water	The growth pathogens inoculated on samples was reduced by 1.2–1.6 log cfu/g after 5 d of storage.	Graca *et al*., , 2011
Apple	*E. coli O157:H7, Salmonella* and *L. innocua*	1 x10^7 cfu/ml	Addition of ascorbic acid	At 5ºC storage, the three bacteria showed the same pattern, populations were lower than control samples *but* ascorbic acid did not shown any valuable effect against pathogens.	Alegre *et al*., 2010
Fruit salads	*S.* Enteritidis E4, *E. coli* 555, and *L. monocytogenes* Scott A	6.0, 5.3, and 5.2 log cfu/g	Citron essential oil (CEO)	CEO had reduced effects on the survival of *S.* Enteritidis and *E. coli*, but showed a strong inhibition toward *L. monocytogenes.*	Belletti *et al*., 2008
Mango and cantaloupe melon	*Escherichia coli* type 1, *Saccharomyces cerevisiae*, *Gluconobacter liquefaciens*, and *L. monocytogenes* Scott A	1 x10^7 cfu/ml	Cold atmospheric plasma pen (CAP-Pen)	Efficient inactivation of all test organisms was obtained. *E. coli* and *L. monocytogenes* count CAP-Pen application is higher on melon than on mango. However, *S. cerevisiae* count on melons and mangoes were not significantly different after 10, 20 and 30 s, but the differences were significant after 40 s.	Perni *et al*., 2008
Fuji apple	*L. innocua*	10^6 cfu/ml	Edible coatings containing EOs (lemongrass, oregano oil and vanillin)	The use of alginate-apple puree coatings with EOs reduced the microorganism levels in fresh-cut apple as compared to apple pieces coated without incorporation of EOs.	Rojas-Graü *et al*., 2007

In general, washing is applied to remove residues, dirt and microorganisms during FCFs processing and chlorine is traditionally used as a sanitizer at 50−200 ppm concentrations during washing. However, this chlorine treatment is not efficient for the complete inactivation of pathogens. Besides, chlorine is corrosive and can react with organic compounds and produce carcinogens, so most European countries (Netherlands, Germany, Sweden and Belgium) have prohibited chlorine and chlorine-based compounds (**Yi *et al*., 2020**).

Numerous preventive strategies can be applied to maintain FCFs' safety. H_2O_2, ozone, organic acids (e.g. acetic, citric, succinic, malic, tartaric, benzoic, propanoic and sorbic acids) and peroxyacetic acids used as an alternative to chlorine also have limited effects in killing microorganisms (**Prakash *et al*., 2018**). Furthermore, bio-preservation methods, defined as the "use of living organisms to suppress the population density or impact of a specific pest organism, making it less abundant or less damaging than it would otherwise be" (**Eilenberg *et al*., 2001**) are preferred in order to inhibit microbial growth and increase shelf life of FCFs. In this process, bacteriocins, which are antimicrobial peptides produced by LAB, generally play a role (**Leneveu-Jenvrin *et al*., 2019**). Except from antimicrobial compounds, the microbial polysaccharides produced by LAB also have shown significant antibacterial activity against pathogens. In the study carried by **Alegre *et al.* (2011)**, the possibility of enrichment of minimally processed apples with the probiotic *L. rhamnosus* GG was evaluated and also the effect against pathogenic bacteria which are *L. monocytogenes* and *Salmonella* were investigated. They concluded addition of *L. rhamnosus* GG could reduce the count of *L. monocytogenes* by 1-log unit on samples. However, probiotic strain did not affect *Salmonella* population. Thus, *L. rhamnosus* GG may be used as a protective agent against *L. monocytogenes* and infection caused by ingestion of spoiled fruits could be reduced while acquiring higher shelf life of products.

Also, applying non-thermal cold plasma technique is an alternative method in order to obtain safe products. In a study performed by **Li *et al*. (2019** the non-thermal cold plasma method was applied on fresh cut pitaya (*Hylocereus undatus*) fruit. The results showed that total aerobic bacteria can be inhibited with this novel technique while increasing the antioxidant activity of fresh-cut pitaya fruits. Other prevention approaches such as aromatic plant and their extracts, essential oils, bacteriophages, metabolites of probiotics, modified atmosphere packaging (MAP), edible antimicrobial coatings, radio-frequency plasma, pulsed light, UV-C, sonication and electrolyzed water are also used to ensure safety and quality of FCFs (Tab 3). However, all these new prevention methods may not be sufficient to guarantee the safety of FCFs. Therefore, different types of physical, chemical and biological technologies or combination of two or more of these approaches with increased antimicrobial effectiveness that can be applied to FCFs should be studied, and their applicability to food industry should be considered. The prevention methods should be sustainable, economical, complying with regulations and acceptable for consumers. In addition to these, the use of omic technologies, namely metabolomics and proteomics, has become widespread recently to investigate the current microbial safety and quality of FCFs. For this purpose, biomarkers/biological markers are used and the safety of the FCFs is ensured (**More *et al*., 2019**). Thanks to the biological markers such as stress, freshness and volatiles that can act as fingerprints for relevant changes in the fresh produce, substances resulting from postharvest metabolic changes can be detected easily. Consequently, it is important to use such biochemical markers to decide strategies to improve fresh produce quality and safety.

CONCLUSION

People have become more interested in fresh products since they seem healthy and convenient. Among these products, fruits are important in daily diet and people prefer to consume pre-cut fruits because they are more favorable. Moreover, it takes less time to prepare and serve such products. Thus, FCFs are considered as time-saving and practical compared to whole fruits.

Minimally processed fruits are sold at various markets, but they may pose risk for public health. Mainly, FCFs were contaminated with bacteria, generally *E. coli*, *S. aureus*, and *Salmonella* spp. However, they seemed suitable for consumption. If the products are not produced or stored under right conditions, they cause a risk of foodborne diseases. Considering the increasing demands of consumers and the food industry, prevention of foodborne diseases due to FCFs consumption has become an important issue to protect consumers' health. The safety of these products is mainly based on correct cold chain and hygienic practices and so good hygiene practices must be applied by both producers and processors in order to avoid contamination and bacterial growth in FCFs. Distributors, retailers, and consumers must be aware of storage conditions that are important to prevent microbial growth. In addition to these, the quality and safety of fresh produce are difficult to control as they can be influenced by many different factors throughout processes, including postharvest handling, processing, packaging and storage. For this purpose, changes in their quality and safety can be monitored using biomarkers that have become widespread recently, and this can help prevent a possible outbreak.

In this review, recent outbreaks caused by FCFs consumption were summarized. When a foodborne outbreak is suspected, different pathogens and disease symptoms should be characterized, and the etiology of the possible outbreak as supported by the incubation period, the types of symptoms experienced, and data analysis results should be described. The obtained data showed that the late outbreaks caused by FCFs resulted 466 illnesses, 167 hospitalizations and 1 death, where the responsible microorganisms have been identified as *Salmonella* spp. In order to prevent outbreaks caused by consumption of contaminated FCFs, hygiene and sanitation conditions must be provided for all steps of the process. In addition, future researches should be focused on hurdle effect called a combination of various preservative approaches and an important application for the prevention of microbial growth in ensuring the safety of FCFs and preventing the occurrence of foodborne diseases.

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REFERENCES

Abadias, M., Usall, J., Anguera, M., Solsona, C., & Viñas, I. (2008). Microbiological quality of fresh, minimally-processed fruit and vegetables, and sprouts from retail establishments. *International Journal of Food Microbiology*, *123*(1-2), 121–129. https://doi.org/10.1016/j.ijfoodmicro.2007.12.013

Abadias, M., Alegre, I., Oliveira, M., Altisent, R., & Viñas, I. (2012). Growth potential of *Escherichia coli* O157:H7 on fresh-cut fruits (melon and pineapple) and vegetables (carrot and escarole) stored under different conditions. *Food Control, 27*(1), 37-44. https://doi.org/10.1016/j.foodcont.2012.02.032

Alegre, I., Abadias, M., Anguera, M., Oliveira, M., & Viñas, I. (2010). Factors affecting growth of foodborne pathogens on minimally processed apples. *Food Microbiology, 27(1), 70–76.* https://doi.org/10.1016/j.fm.2009.08.005

Alegre, I., Viñas, I., Usall, J., Anguera, M., & Abadias, M. (2011). *Microbiological and physicochemical quality of fresh-cut apple enriched with the probiotic strain Lactobacillus rhamnosus GG. Food Microbiology, 28(1), 59–66.* https://doi.org/10.1016/j.fm.2010.08.006

Alegre, I., Viñas, I., Usall, J., Teixidó, N., Figge, M. J., & Abadias, M. (2013). Control of foodborne pathogens on fresh-cut fruit by a novel strain of Pseudomonas graminis. *Food Microbiology, 34(2),* 390–399. https://doi.org/10.1016/j.fm.2013.01.013

Ali, F., Harris, K.J., & Ryu, K. (2019). Consumers' return intentions towards a restaurant with foodborne illness outbreaks: Differences across restaurant type and consumers' dining frequency. *Food Control, 98,* 424-430. https://doi.org/10.1016/j.foodcont.2018.12.001

Althaus, D., Hofer, E., Corti, S., Julmi, A., & Stephan, R. (2012). Bacteriological survey of ready-to-eat lettuce, fresh-cut fruit, and sprouts collected from the Swiss market. *Journal of Food Protection*, *75*(7), 1338-1341. https://doi.org/10.4315/0362-028X.JFP-12-022

Barbosa, A. A. T., de Araújo, H. G. S., Matos, P. N., Carnelossi, M. A. G., & de Castro, A. A. (2013). Effects of nisin-incorporated films on the microbiological and physicochemical quality of minimally processed mangoes. *International Journal of Food Microbiology*, *164*(2-3), 135-140. https://doi.org/10.1016/j.ijfoodmicro.2013.04.004

Baselice, A., Colantuoni, F., Lass, D.A., Nardone, G., & Stasi, A. (2017). Trends in EU consumers' attitude towards fresh-cut fruit and vegetables. *Food Quality and Preference*, *59*, 87-96. https://doi.org/10.1016/j.foodqual.2017.01.008

Beaulieu, J.C., & Gorny, J.R., (2016). Fresh-cut fruits, In K.C. Gross, C.Y. Wang, & M.E. Saltveit (Eds.), *The commercial storage of fruits, vegetables, and florist and nursery stocks* (pp. 604-624). United States Department of Agriculture.

Belgacem, I., Schena, L., Teixidó, N., Romeo, F.V., Ballistreri, G., & Abadias, M. (2020). Effectiveness of a pomegranate peel extract (PGE) in reducing Listeria monocytogenes in vitro and on fresh-cut pear, apple and melon. *European Food Research and Technology*, *246*, 1765-1772. https://doi.org/10.1007/s00217-020-03529-5

Belletti, N., Lanciotti, R., Patrignani, F., & Gardini, F. (2008). Antimicrobial efficacy of citron essential oil on spoilage and pathogenic microorganisms in fruit-based salads. *Journal of Food Science*, *73*(7), M331-M338. https://doi.org/10.1111/j.1750-3841.2008.00866.x

Benítez, S., Achaerandio, I., Pujolà, M., & Sepulcre, F. (2015). Aloe vera as an alternative to traditional edible coatings used in fresh-cut fruits: A case of study with kiwifruit slices. *LWT-Food Science and Technology*, *61*(1), 184-193. https://doi.org/10.1016/j.lwt.2014.11.036

Bhagwat, A.A. (2005). Microbiological safety of fresh-cut produce: where are we now? (Chapter 5) Washington, D.C: ASM Press.

Byrne, L., Fisher, I., Peters, T., Mather, A., Thomson, N., Rosner, B., ... & Aiyedun, V. (2014). A multi-country outbreak of Salmonella Newport gastroenteritis in Europe associated with watermelon from Brazil, confirmed by whole genome sequencing: October 2011 to January 2012. *Eurosurveillance*, *19*(31), 20866.

Callejón, R.M., Rodriguez-Naranjo, M.I., Ubeda, C., Hornedo-Ortega, R., Garcia-Parrilla, M.C., & Troncoso, A.M. (2015). Reported foodborne outbreaks due to fresh produce in the United States and European Union: trends and causes. *Foodborne Pathogens and Disease*, *12*(1), 32-38. http://doi.org/10.1089/fpd.2014.1821

CDC, Centre for Disease Control and Prevention. (2019a). Outbreak of *Salmonella* Infections Linked to Cut Fruit. https://www.cdc.gov/salmonella/javiana-12-19/ Accessed 11 February 2020.

CDC, Centre for Disease Control and Prevention. (2019b). Outbreak of *Salmonella* Infections Linked to Pre-Cut Melons. https://www.cdc.gov/salmonella/carrau-04-19/index.html/ Accessed 11 February 2020.

CDC, Centre for Disease Control and Prevention. (2018). Multistate Outbreak of *Salmonella* Adelaide Infections Linked to Pre-Cut Melon (Final Update) . https://www.cdc.gov/salmonella/adelaide-06-18/ Accessed 10 February 2020.

CDC, Centers for Disease Control. (2017). Foodborne Outbreak Tracking and Reporting. https://www.cdc.gov/foodsafety/fdoss/overview/index.html/ Accessed 11 February 2020.

Chatziprodromidou, I.P., Bellou, M., Vantarakis, G., & Vantarakis, A. (2018). Viral outbreaks linked to fresh produce consumption: a systematic review. *Journal of Applied Microbiology*, *124*(4), 932-942. https://doi.org/10.1111/jam.13747
Chen, C., Liu, C., Jiang, A., Guan, Q., Sun, X., Liu, S., ... & Hu, W. (2019). The effects of cold plasma-activated water treatment on the microbial growth and antioxidant properties of fresh-cut pears. *Food and Bioprocess Technology*, *12*(11), 1842-1851. https://doi.org/10.1007/s11947-019-02331-w
Chukwu, C.O.C., Chukwu, I.D., Onyimba, I.A., Umoh, E.G., Olarubofin, F., & Olabode, A.O. (2010). Microbiological quality of pre-cut fruits on sale in retail outlets in Nigeria. *African Journal of Agricultural Research*, *5*(17): 2272-2275.
Colás-Medà, P., Viñas, I., Alegre, I., & Abadias, M. (2017). The impact of a cold chain break on the survival of *Salmonella enterica* and *Listeria monocytogenes* on minimally processed 'Conference'pears during their shelf life. *Journal of the Science of Food and Agriculture*, *97*(9), 3077-3080. https://doi.org/10.1002/jsfa.8127
Collazo, C., Abadias, M., Aguiló-Aguayo, I., Alegre, I., Chenoll, E., & Viñas, I. (2017). Studies on the biocontrol mechanisms of *Pseudomonas graminis* strain CPA-7 against food-borne pathogens in vitro and on fresh-cut melon. *LWT-Food Science and Technology*, *85*, 301-308. https://doi.org/10.1016/j.lwt.2017.02.029
Costa, C., Conte, A., Buonocore, G.G., & Del Nobile, M.A. (2011). Antimicrobial silver-montmorillonite nanoparticles to prolong the shelf life of fresh fruit salad. *International Journal of Food Microbiology. 148*(3), 164-167. https://doi.org/10.1016/j.ijfoodmicro.2011.05.018
Corbo, M.R., Speranza, B., Campaniello, D., D'Amato, D., & Sinigaglia, M. (2010). Fresh cut fruits preservation: current status and emerging technologies, In A. Méndez-Vilas (Ed.), *Current Research, Technology and Education Topics in Applied Microbiology and Microbial Biotechnology* (pp. 1143–1154). Formatex Research Center.
De Corato, U. (2020). Improving the shelf-life and quality of fresh and minimally-processed fruits and vegetables for a modern food industry: A comprehensive critical review from the traditional technologies into the most promising advancements. *Critical Reviews in Food Science and Nutrition, 60*(6), 940-975. https://doi.org/10.1080/10408398.2018.1553025
Denis, N., Zhang, H., Leroux, A., Trudel, R., & Bietlot, H. (2016). Prevalence and trends of bacterial contamination in fresh fruits and vegetables sold at retail in Canada. *Food Control*, *67*, 225-234. https://doi.org/10.1016/j.foodcont.2016.02.047
ECDC, European Centre for Disease Control and Prevention. (2013). Annual Epidemiological Report 2013 [2011 data] https://www.ecdc.europa.eu/en/publications-data/annual-epidemiological-report-2013-2011-data Accessed 25 July 2020.
Eilenberg, J., Hajek, A., & Lomer, C. (2001). Suggestions for unifying the terminology in biological control. *BioControl, 46*(4), 387-400.
Feng, K., Hu, W., Jiang, A., Saren, G., Xu, Y., Ji, Y., & Shao, W. (2017). Growth of *Salmonella* spp. and *Escherichia coli* O157:H7 on fresh-cut fruits stored at different temperatures. *Foodborne Pathogens and Disease*, *14*(9), 510–517. https://doi.org/10.1089/fpd.2016.2255
Francis, G.A., Gallone, A., Nychas, G.J., Sofos, J. N., Colelli, G., Amodio, M. L., & Spano, G. (2012). Factors affecting quality and safety of fresh-cut produce. *Critical Reviews in Food Science and Nutrition*, *52*(7), 595-610. https://doi.org/10.1080/10408398.2010.503685
Graca, A., Abadias, M., Salazar, M., & Nunes, C. (2011). The use of electrolyzed water as a disinfectant for minimally processed apples. *Postharvest Biology and Technology*, *61*(2-3), 172-177.
Graça, A., Esteves, E., Nunes, C., Abadias, M., & Quintas, C. (2017). Microbiological quality and safety of minimally processed fruits in the marketplace of southern Portugal. *Food Control, 73*, 775-783. https://doi.org/10.1016/j.foodcont.2016.09.046
Graça, A., Santo, D., Esteves, E., Nunes, C., Abadias, M., & Quintas, C. (2015). Evaluation of microbial quality and yeast diversity in fresh-cut apple. *Food Microbiology*, *51*, 179-185. https://doi.org/10.1016/j.fm.2015.06.003
Gupta, C., & Prakash, D. (2019). *Safety of fresh fruits and vegetables*. (1st ed.). Academic Press, (Chapter 10). https://doi.org/10.1016/B978-0-12-816333-7.00010-2
Harris, L.J., Farber, J.N., Beuchat, L.R., Parish, M.E., Suslow, T.V., Garrett, E.H., & Busta, F.F. (2003). Outbreaks associated with fresh produce: incidence, growth, and survival of pathogens in fresh and fresh-cut produce. *Comprehensive Reviews in Food Science and Food Safety, 2,* 78-141. http://dx.doi.org/10.1111/j.1541-4337.2003.tb00031.x
Hu, W., Feng, K., Xiu, Z., Jiang, A., & Lao, Y. (2019). Efficacy of thyme oil-alginate-based coating in reducing foodborne pathogens on fresh-cut apples. *International Journal of Food Science & Technology, 54*(12), 3128-3137. https://doi.org/10.1111/ijfs.14229
Huang, J., Luo, Y., Zhou, B., Zheng, J., & Nou, X. (2019). Growth and survival of Salmonella enterica and Listeria monocytogenes on fresh-cut produce and their juice extracts: impacts and interactions of food matrices and temperature abuse conditions. *Food Control*, *100*, 300-304. https://doi.org/10.1016/j.foodcont.2018.12.035
Iglesias, M.B., Abadias, M., Anguera, M., Sabata, J., & Vi, I. (2017). Antagonistic effect of probiotic bacteria against foodborne pathogens on fresh-cut pear. *LWT-Food Science and Technology*, *81*, 243-249. https://doi.org/10.1016/j.lwt.2017.03.057
Iglesias, M.B., López, M.L., Echeverría, G., Viñas, I., Zudaire, L., & Abadias, M. (2018). Evaluation of biocontrol capacity of *Pseudomonas graminis* CPA-7 against foodborne pathogens on fresh-cut pear and its effect on fruit volatile compounds. *Food Microbiology*, *76*, 226-236. https://doi.org/10.1016/j.fm.2018.04.007
James, J.B., Ngarmsak, T., & Rolle, R.S. (2010). Processing of fresh-cut tropical fruits and vegetables: A technical guide. RAP Publication (FAO) eng no. 2010/16.
Jideani, A.I.O., Anyasi, T.A., Mchau, G.R.A., Udoro, E.O., & Onipe, O.O. (2017). Processing and preservation of fresh-cut fruit and vegetable product. In I. Kahramanoglu (Ed.), *Postharvest handling* (pp. 47-74), InTech Open.
Kabelitz, T., & Hassenberg, K. (2018). Control of apple surface microflora for fresh-cut produce by post-harvest hot-water treatment. *LWT, 98*, 492-499. https://doi.org/10.1016/j.lwt.2018.08.062
Koh, P.C., Noranizan, M.A., Karim, R., & Hanani, Z.A.N. (2016). Microbiological stability and quality of pulsed light treated cantaloupe (Cucumis melo L. reticulatus cv. Glamour) based on cut type and light fluence. *Journal of Food Science and Technology*, 53(4), 1798-1810. https://doi.org/10.1007/s13197-015-2139-y
Lamikanra, O., Chen, J. C., Banks, D., & Hunter, P. A. (2000). Biochemical and microbial changes during the storage of minimally processed cantaloupe. *Journal of Agricultural and Food Chemistry, 48*(12), 5955-5961. https://doi.org/10.1021/jf0000732
Leneveu-Jenvrin, C., Charles, F., Barba, F. J., & Remize, F. (2019). Role of biological control agents and physical treatments in maintaining the quality of fresh and minimally-processed fruit and vegetables. *Critical Reviews in Food Science and Nutrition*, 1-19. https://doi.org/10.1080/10408398.2019.1664979
Leneveu-Jenvrin, C., Quentin, B., Assemat, S., Hoarau, M., Meile, J. C., & Remize, F. (2020). Changes of Quality of Minimally-Processed Pineapple (Ananas comosus, var.'Queen Victoria') during Cold Storage: Fungi in the Leading Role. *Microorganisms*, *8*(2), 185. https://doi.org/10.3390/microorganisms8020185
Li, X., Li, M., Ji, N., Jin, P., Zhang, J., Zheng, Y., … Li, F. (2019). Cold plasma treatment induces phenolic accumulation and enhances antioxidant activity in fresh-cut pitaya (Hylocereus undatus) fruit. *LWT, 115*, 108447. http://dx.doi.org/10.1016/j.lwt.2019.108447.
Lopez, K., Phalen, K., Vahl, C. I., Roberts, K. R., & Getty, K. J. (2016). Investigation of handling practices for fresh produce and the efficacy of commercially available produce washes on removal of pathogens and natural microflora on whole cantaloupe surfaces. *Food Control, 68*, 251-259. https://doi.org/10.1016/j.foodcont.2016.03.050
Mantilla, N., Castell-Perez, M.E., Gomes, C., & Moreira, R.G. (2013). Multilayered antimicrobial edible coating and its effect on quality and shelf-life of fresh-cut pineapple (*Ananas comosus*). *LWT-Food Science and Technology, 51*(1), 37-43. https://doi.org/10.1016/j.lwt.2012.10.010
Matan, N., Puangjinda, K., Phothisuwan, S., & Nisoa, M. (2015). Combined antibacterial activity of green tea extract with atmospheric radio-frequency plasma against pathogens on fresh-cut dragon fruit. *Food Control, 50*, 291-296. https://doi.org/10.1016/j.foodcont.2014.09.005
Montero-Calderón, M., Rojas-Graü, M. A., & Martín-Belloso, O. (2008). Effect of packaging conditions on quality and shelf-life of fresh-cut pineapple (Ananas comosus). *Postharvest Biology and Technology, 50*(2-3), 182-189. https://doi.org/10.1016/j.postharvbio.2008.03.014
More, A.S., Ranadheera, C.S., Fang, Z., Warner, R., & Ajlouni, S. (2019). Biomarkers associated with quality and safety of fresh-cut produce. *Food Bioscience, 34,* 100524. https://doi.org/10.1016/j.fbio.2019.100524
Neetoo, H., Ramasawmy, B., Ruggoo, A., Hardowar, S., Rungasamy, I., & Jaumdally, W. (2019). A comparative assessment of the quality of minimally processed pineapples sold in wet markets and supermarkets of mauritius. *Current Research in Nutrition and Food Science Journal, 7*(1), 128-141. http://dx.doi.org/10.12944/CRNFSJ.7.1.13
Nyarko, E., Kniel, K.E., Reynnells, R., East, C., Handy, E.T., Luo, Y., ... & Sharma, M. (2016). Survival and growth of *Listeria monocytogenes* on fresh-cut "athena" and "rocky ford" cantaloupes during storage at 4°C and 10°C. *Foodborne Pathogens and Disease*, *13*(11), 587-591. https://doi.org/10.1089/fpd.2016.2160
Oliveira, M., Abadias, M., Usall, J., Torres, R., Teixidó, N., & Viñas, I. (2015). Application of modified atmosphere packaging as a safety approach to fresh-cut fruits and vegetables–A review. *Trends in Food Science & Technology, 46*(1), 13-26. https://doi.org/10.1016/j.tifs.2015.07.017
Oliveira, M., Viñas, I., Colàs, P., Anguera, M., Usall, J., & Abadias, M. (2014). Effectiveness of a bacteriophage in reducing *Listeria monocytogenes* on fresh-cut fruits and fruit juices. *Food Microbiology, 38*, 137-142. https://doi.org/10.1016/j.fm.2013.08.018
Olmez, H. (2016). Foodborne pathogenic bacteria in fresh-cut vegetables and fruits. In P. Kotzekidou (Ed.), *Food hygiene and toxicology in ready-to-eat foods* (pp. 151-166). Academic Press.
Oluk, C.A. (2018). Storage Methods of Minimal Processed Fruits and Vegetables. *International Journal of Eastern Mediterranean Agricultural Research, 1*(1), 96-130.
Perni, S., Shama, G., & Kong, M.G. (2008). Cold atmospheric plasma disinfection of cut fruit surfaces contaminated with migrating microorganisms. *Journal of Food Protection, 71*(8), 1619-1625. https://doi.org/10.4315/0362-028X-71.8.1619

Piano, A.M.P., & Castillo-Israel, K.A.T. (2019). Physico-chemical quality and microbial safety evaluation of ready-to-eat fresh-cut watermelon and pineapple sold in Imus, Cavite, Philippines. *Food Research, 3*(6), 684-692.

Pinheiro, N.M.D.S., Figueiredo, E.A.T.D., Figueiredo, R.W.D., Maia, G.A., & Souza, P.H. M.D. (2005). Avaliação da qualidade microbiológica de frutos minimamente processados comercializados em supermercados de Fortaleza. *Revista Brasileira de Fruticultura, 27*(1), 153-156. https://doi.org/10.1590/S0100-29452005000100040

Prakash, A., Nithyanand, P., & Vadivel, V. (2018). In vitro antibacterial activity of nut by-products against foodborne pathogens and their application in fresh-cut fruit model. *Journal of Food Science and Technology, 55*(10), 4304-4310. https://doi.org/10.1007/s13197-018-3373-x

Purayidathil, F.W., & Ibrahim, J. (2012). A summary of health outcomes: Multistate foodborne disease outbreaks in the US, 1998–2007. *Journal of Environmental Health, 75*(4), 8-13.

Qadri, O.S., Yousuf, B., & Srivastava, A.K. (2015). Fresh-cut fruits and vegetables: Critical factors influencing microbiology and novel approaches to prevent microbial risks. A review. *Cogent Food & Agriculture, 1*(1). https://doi.org/10.1080/23311932.2015.1121606

Ramos-Villarroel, A.Y., Martín-Belloso, O., & Soliva-Fortuny, R. (2015). Combined effects of malic acid dip and pulsed light treatments on the inactivation of *Listeria innocua* and *Escherichia coli* on fresh-cut produce. *Food Control, 52*, 112-118. https://doi.org/10.1016/j.foodcont.2014.12.020

Rojas-Graü, M.A., Raybaudi-Massilia, R.M., Soliva-Fortuny, R.C., Avena-Bustillos, R.J., McHugh, T.H., & Martín-Belloso, O. (2007). Apple puree-alginate edible coating as carrier of antimicrobial agents to prolong shelf-life of fresh-cut apples. *Postharvest biology and Technology, 45*(2), 254-264. https://doi.org/10.1016/j.postharvbio.2007.01.017

Russo, P., de Chiara, M. L. V., Vernile, A., Amodio, M. L., Arena, M. P., Capozzi, V., ... & Spano, G. (2014). Fresh-cut pineapple as a new carrier of probiotic lactic acid bacteria. *BioMed Research International, 2014*, 1-9. https://doi.org/10.1155/2014/309183

Rux, G., Efe, E., Ulrichs, C., Huyskens-Keil, S., Hassenberg, K., & Herppich, W.B. (2019). Effects of pre-processing short-term hot-water treatments on quality and shelf life of fresh-cut apple slices. *Foods, 8*(12), 653. https://doi.org/10.3390/foods8120653

Salvia-Trujillo, L., Rojas-Graü, M.A., Soliva-Fortuny, R., & Martín-Belloso, O. (2015). Use of antimicrobial nanoemulsions as edible coatings: Impact on safety and quality attributes of fresh-cut Fuji apples. *Postharvest Biology and Technology, 105*, 8-16. https://doi.org/10.1016/j.postharvbio.2015.03.009

Sanchís, E., Ghidelli, C., Sheth, C.C., Mateos, M., Palou, L., & Pérez-Gago, M.B. (2017). Integration of antimicrobial pectin-based edible coating and active modified atmosphere packaging to preserve the quality and microbial safety of fresh-cut persimmon (*Diospyros kaki* Thunb. cv. Rojo Brillante). *Journal of the Science of Food and Agriculture, 97*(1), 252-260. https://doi.org/10.1002/jsfa.7722

Sandulachi, E. (2010). Water activity concept and its role in food preservation. http://www.fao.org/3/y4358e/y4358e06.htm/ Accessed 11 February 2020.

Santo, D., Graça, A., Nunes, C., & Quintas, C. (2016). Survival and growth of *Cronobacter sakazakii* on fresh-cut fruit and the effect of UV-C illumination and electrolyzed water in the reduction of its population. *International Journal of Food Microbiology, 231*, 10-15. https://doi.org/10.1016/j.ijfoodmicro.2016.04.023

Scollard, J., McManamon, O., & Schmalenberger, A. (2016). Inhibition of *Listeria monocytogenes* growth on fresh-cut produce with thyme essential oil and essential oil compound verbenone. *Postharvest Biology and Technology, 120*, 61-68. https://doi.org/10.1016/j.postharvbio.2016.05.005

Sengun, I.Y., & Karapinar, M. (2006). Inactivation of *Salmonella typhimurium* inoculated on some vegetables by using lemon juice and vinegar (In Turkish). *GIDA, 31*(3): 161-167.

Singh, A., Walia, D., & Batra, N. (2018). Fresh-cut fruits, microbial degradation and preservation, In A.M. Holban & A.M. Grumezescu (Eds.), *Microbial contamination and food degradation* (pp. 149-176), Academic Press.

Sureshkumar, K., Hariharan, B., & Vidyalakshmi, R. (2016). Microbiological quality of fresh cut fruit salad sold in Thanjavur City. *Journal of Pure and Applied Microbiology, 10*(2), 1081-1088.

Thakur, R.J., Shaikh, H., Gat, Y., & Waghmare, R.B. (2019). Effect of calcium chloride extracted from eggshell in maintaining quality of selected fresh-cut fruits. *International Journal of Recycling of Organic Waste in Agriculture, 8*(1), 27-36. https://doi.org/10.1007/s40093-019-0260-z

Tirado, M.C., Clarke, R., Jaykus, L.A., McQuatters-Gollop, A., & Frank, J.M. (2010). Climate change and food safety: A review. *Food Research International, 43*(7), 1745. http://dx.doi.org/10.1016/j.foodres.2010.07.003

Tournas, V. H., Heeres, J., & Burgess, L. (2006). Moulds and yeasts in fruit salads and fruit juices. *Food Microbiology, 23*(7), 684-688. https://doi.org/10.1016/j.fm.2006.01.003

Treviño-Garza, M.Z., García, S., Heredia, N., Alanís-Guzmán, M.G., & Arévalo-Niño, K. (2017). Layer-by-layer edible coatings based on mucilages, pullulan and chitosan and its effect on quality and preservation of fresh-cut pineapple (*Ananas comosus*). *Postharvest Biology and Technology, 128*, 63-75. https://doi.org/10.1016/j.postharvbio.2017.01.007

Viswanathan, P., & Kaur, R. (2001). Prevalence and growth of pathogens on salad vegetables, fruits and sprouts. *International Journal of Hygiene and Environmental Health, 203*(3), 205-213. https://doi.org/10.1078/S1438-4639(04)70030-9

Wang, Q., Erickson, M., Ortega, Y.R., & Cannon, J.L. (2013). The fate of murine norovirus and hepatitis A virus during preparation of fresh produce by cutting and grating. *Food and Environmental Virology, 5*(1), 52-60. http://dx.doi.org/10.1007/s12560-012-9099-4.

Wong, C. H., Mak, I. E. K., & Li, D. (2021). Bilayer edible coating with stabilized Lactobacillus plantarum 299v improved the shelf life and safety quality of fresh-cut apple slices. *Food Packaging and Shelf Life*, 30, 100746. https://doi.org/10.1016/j.fpsl.2021.100746

WSDOH, Washington State Department of Health. Salmonella Newport and Pre-cut Fruit, Washington and Oregon. (2017). http://outbreakdatabase.com/reports/2017_Salmonella_cut_fruit_WA_DOH_12-1-17.pdf./ Accessed 11 February 2020.

Wu, Y.N., Liu, X.M., Chen, Q., Liu, H., Dai, Y., Zhou, Y.J., ... & Chen, Y. (2018). Surveillance for foodborne disease outbreaks in China, 2003 to 2008. *Food Control*, 84, 382-388. https://doi.org/10.1016/j.foodcont.2017.08.010.

Wu, Z.S., Zhang, M., & Adhikari, B. (2012). Application of high pressure argon treatment to maintain quality of fresh-cut pineapples during cold storage. *Journal of Food Engineering, 110*(3), 395-404. https://doi.org/10.1016/j.jfoodeng.2011.12.032

Yi, L., Qi, T., Ma, J., & Zeng, K. (2020). Genome and metabolites analysis reveal insights into control of foodborne pathogens in fresh-cut fruits by *Lactobacillus pentosus* MS031 isolated from Chinese Sichuan Paocai. *Postharvest Biology and Technology, 164*, 111150. http://dx.doi.org/10.1016/j.postharvbio.2020.111150

Yoon, J.H., Bae, Y. M., Jung, K.S., Heu, S., & Lee, S.Y. (2013). Combined effect of calcium oxide and sonication to reduce foodborne pathogens on fresh produce. *Food Science and Biotechnology, 22*(1), 275-278. https://doi.org/10.1007/s10068-013-0037-5

Zhang, G., Chen, Y., Hu, L., Melka, D., Wang, H., Laasri, A., ... & Parish, M. (2018). Survey of foodborne pathogens, aerobic plate counts, total coliform counts, and *Escherichia coli* counts in leafy greens, sprouts, and melons marketed in the United States. *Journal of Food Protection, 81*(3), 400-411. https://doi.org/10.4315/0362-028X.JFP-17-253

Zhou, Z., Zuber, S., Cantergiani, F., Butot, S., Li, D., Stroheker, T., ... & Uyttendaele, M. (2017). Inactivation of viruses and bacteria on strawberries using a levulinic acid plus sodium dodecyl sulfate based sanitizer, taking sensorial and chemical food safety aspects into account. *International Journal of Food Microbiology, 257*, 176-182. http://dx.doi.org/10.1016/j.ijfoodmicro.2017.06.023