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Review

Quality assurance requirements in produce processing

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The increasing consumption of produce has resulted in increasing concern by the food industry with respect to the safety of these products. Quality assurance norms covering all the processing steps, from farm to table, have become obligatory and assume a fundamental role in process innocuousness. This review contains information on the main factors responsible for the elaboration of a quality assurance system for produce plants: good agricultural practices (GAP) and good manufacturing practices (GMP), including the sanitation standard operating procedures (SSOP) and hazard analysis and critical control points (HACCP).

Introduction

Minimally processed products (fruits and/or vegetables) are defined as those prepared by a single or any number of appropriate unit operations such peeling, slicing, shredding, juicing, *etc*. given a partial but not end-point preservation treatment (Wiley, 1994). The objective is to provide the consumer with a product similar to the fresh product, but at the same time assuring its safety and maintaining its nutritional and sensory quality (Reyes, 1996). In addition, they aims to satisfy the increasing need of the world population to consume more vegetables, adapting to the contemporary tendency to consume healthy convenient food at meals, rapid or otherwise, at both domestic and institutional levels, in a society where the individual has constantly less time available to dedicate himself to food preparation. In this context, process hygiene should be constantly monitored so that the products offer no risks to public health. Sivapalasingam, Friedman, Cohen, and Tauxe (2004) reported the existence of 190 food poisoning outbreaks associated with minimally processed products, resulting in 16,058 case studies, 598 hospital internments and five deaths in the USA between 1973 and 1997. In Brazil, due to the fragility of the epidemiological system, no reports of food poisoning outbreaks caused by minimally processed vegetables exist. Nevertheless, it is assumed that the situation is not encouraging.

Quality assurance

The definition of quality is part of a polemic discussion, since it depends on both subjective and objective factors. The subjective factors include cultural, economic, psychological, religious and ethical aspects, creating a wide range of quality concepts. The objective factors include standardisation of the organoleptic and physicochemical characteristics and food safety assurance (Ilbery & Kneafsey, 2000, cited by Oliveira & Masson, 2003). Quality assurance is included in a preventative approach dealing with all hazards involved in the food processing steps, acting as a control of quality in each step of the process, decreasing the responsibility of the microbial death step and increasing confidence in the final product, involving the application of written procedures associated with specific and necessary verifications (Gonçalo, 2003).

For minimally processed vegetables, where this step does not exist, the adoption of quality assurance systems by the producers becomes obligatory and crucial in order to decrease the physical, chemical and microbiological risks associated with the product, from the planting and harvest in the field to the processing in the industrial unit, putting into practice the 'from farm to table' food safety concept, standardising the different process activities in addition to creating conditions for an effective tracer system. This

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means that the adoption of good manufacturing practices (GMP), sanitation standard operating procedures (SSOP) and the hazard analysis and critical control point system (HACCP), already exhaustively discussed in the food industry, must obligatorily be accompanied by quality norms for the primary product (raw material), expressed by the good agricultural practices (GAP) in order to implement a quality assurance system for the products.

Good agricultural practices (GAP)

According to the US Department of Health of Human Services, FDA and CFSAN (1998), good agricultural practices are general procedures to reduce hazards related to product safety at the farm level during the operations which precede processing: cultivation, development, harvest and storage, being considered a prerequisite for the implementation of a HACCP plan at the farm level. Its importance has been recognised in various countries throughout the world: in Great Britain, the *Assured Produce Scheme* (APS) was launched in 1998 as a result of a union between producers, processors and retailers, to promote a safe and self-sustaining production of vegetables, fruits and salads by an integrated management of agriculture and reduced use of pesticides; In Israel, *Ecofresh* (1997) was based on consumer demand for pesticide-free products, protection of the environment and the food safety requirement by retailers incorporating HACCP as an integral part; In Chile, in 2000, *good agricultural practices* were launched by the Association of Chilean Exporters, focussing on an effective monitoring of pesticide residues and a rigid control of the food safety and hygiene laws (Seaton, 2001).

Topics referred to in GAP include anticipating the sources and localities where the product could be contaminated, avoiding or minimising existing risks and the existence of documented procedures for all steps, to assure product safety, although in many cases, the simple observation of current law is enough, such as the construction of hygienic toilet facilities for the workers and the use of organic fertilisers which have been composted, in order to reduce the microbial load (Pabrua, 1999). De Roever (1998) reinforced this idea, affirming the need to establish documented protocols related to irrigation water, the use of fertilisers, hygiene of utensils and workers and transport.

Arts (2001) numbered the GAP topics as follows: (1) quality and processing of irrigation water; (2) fertiliser handling and application; (3) worker and utensil sanitary conditions; (4) traceability.

One of the main safety concerns with respect to minimally processed products is the quality of the irrigation water, as frequently having been shown to contain high counts of enteric bacteria and viruses. Protozoa can also contaminate such products, the level of contamination being related to the form of irrigation and type of product. The greatest level of contamination is found in leafy vegetables, due to their large surface areas and structural characteristics, which facilitate microbial adhesion (De Roever, 1998). Abdul-Rauof, Beuchat, and Ammar (1993) showed the presence of *Escherichia coli O157:H7* in shredded lettuce, and associated its presence with possible contamination of the irrigation water. Irrigation techniques that submit the plant to direct contact with contaminated water (spraying) increase the risk of product contamination as compared to deep irrigation. Solomon, Polenski, and Matthews (2002) studied the transmission of *E. coli O157:H7* in lettuce (64 in all) submitted to spray (32) and surface (32) irrigation, obtaining greater survival of the pathogen in the former case, with 29 positive cases (91% survival for a period of 20 days post-treatment) as compared to the latter, which registered six positive results (19%). Treatment with 200 ppm chlorine for 1 min failed to eliminate the pathogen. Pabrua (1999) reinforced this idea, emphasising the great number of water applications at the farm level: product washing and cooling, pesticide application and irrigation, amongst others, and thus the monitoring of the water quality is of extreme importance, by way of periodic microbiological and chemical analyses, it being necessary to have a complete knowledge of the water source to be used in the various operations.

Howard and Gonzalez (2001) stated that the water quality should be considered in all the operations in which it is involved (irrigation, pesticide and fertiliser application, cooling), and that the sources should be periodically analysed microbiologically for faecal coliforms and *E. coli*. However, one must remember that water safe from the microbiological point of view, is not necessarily free of viruses such as the *Norwalk* and Hepatitis A viruses. Salleh et al. (2003) reported the presence of various *Salmonella* serotypes in raw vegetables in Malaysia, suggesting the irrigation water as a possible source of the contamination. Solomon, Yaron, and Matthews (2002) reported contamination of lettuce and seeds by *E. coli O157:H7*, the source of contamination being the irrigation water. Kirby, Bartram, and Carr (2003) warned that the quality of irrigation water assumes international importance when one considers the exportation of agricultural produce, facilitating the dissemination of pathogens of unknown virulence to regions where they were absent or never found, with serious public health consequences.

Another potential source of pathogenic bacteria in the agricultural environment, which may affect the water used in processing, is the presence of domestic or wild animals (De Roever, 1998). *Salmonella* sp. have been isolated from the intestinal tract of the majority of hot-blooded animals and from many cold-blooded animals. Birds are a singular and important source of contamination due to their ability to transmit bacteria at great distances. Pigeons can serve as vehicles for the introduction of *Listeria monocytogenes*, *Yersinia enterecolitica* and enteric bacteria into agricultural environments, due to their contact with animal manure. In general, rodents, rabbits and other mammals found in the country probably possess enteric pathogens, and are therefore potential sources of contamination both in the direct form in the field and by way of the irrigation water. A complete history of the use to which the region was destined thus becomes a necessity, in order to decide on its viability for the cultivation of agricultural products.

Equally critical for GAP is the existence of adequate toilet facilities for the farm workers. The existence of proper, clean, hygienically constructed installations, of easy access to workers dealing with the product, is indispensable, including clear instructions for their use. Periodic training programmes in language adequate to assure maximum operational efficiency are equally important (Pabrua, 1999). The handlers represent a potential source for transferring pathogens to minimally processed vegetables, especially if accustomed to poor hygiene-sanitary practices, and thus these training programmes deserve special attention, being one of the main challenges faced by processors, due to the great cultural and educational differences of the workers (Hurst, 1995). As with animals, workers accustomed to poor hygiene and sanitary practices may be bearers of enteric pathogens and represent a source of product contamination, since they handle the product (De Roever, 1998). The use of inadequate practices for applying manure should also be taken into consideration in the GAP schemes, since, according to the International Fresh-Cut Produce Association (1999), composting practices should be very closely monitored so as to assure elimination of all pathogens. Beuchat (1999) demonstrated the survival of *E. coli O154:H7* in lettuce stored at 4 °C for up to 15 days, using bovine faeces as the vehicle, even with an initial load of 1–10 CFU/g. *Clostridium botulinum* is frequently present in the soil and in organic fertilisers, and thus vegetables can become contaminated, due to their intimate contact with this pathogen (Notemans, 1993 and Rhodehamel et al., 1992, cited by Francis, Thomas, & O'Beirne, 1999). Although the process of composting can be observed in specific locations far from the plantations, monitoring of this practice is crucial to process safety. Droffner and Briton (1995) reported the survival of *Salmonella* and *E. coli* in composted manure held at 60 °C for at least 59 days. In order to reduce the contamination potential for the minimally processed vegetables, rigid composting methods must be adopted and storage periods of 60 days in the summer and 90 in the winter, before applying to the fields (Howard & Gonzalez, 2001). Of equal importance as a critical item in GAP is the correct handling of pesticides to be used in contact with the product. Only pesticides registered and authorized by the official organs should be used, otherwise they could be a source of product contamination. The efficiency of this operation depends on establishing clear handling instructions, with adequate training of the workers who will handle the substances and registers of each application. A qualified technician should be responsible for the operations and accompany the whole process (International Fresh-Cut Produce Association, 1999). The adoption of GAP is of extreme importance for the quality assurance of the minimally processed vegetable processing and should result in an integrated action between the agro-industrial area (product processing) and the cultivation area, since the raw material is a source of primary contamination with direct impact on the diverse variables constituting the productive process, such as handlers, utensils, equipment and environment (Fain, 1996). Thus, the presence of pathogens and a high microbial load in the raw material can represent a double hazard: a contaminated final product with potential risk for collective health, with the possibility of disseminating the pathogen throughout all the variables of the productive process. Allende, Aguayo, and Artés (2004) reported respective counts of 10^5–10^6 and 10^4–10^6 CFU/g for mesophiles and psychrophiles in the reception stage of processing lines in and Murcia, Spain, being observed average reductions of one and two logarithmic cycles, respectively, being observed after the sanitization step.

Good manufacturing practices (GMP)

GMP are formally called support programs that provides foundations for HACCP in a overall food safety management programme. Topics controlled for it are related to the environmental processing line, for, e.g. cleaning, preventative maintenance, personnel and training, calibration equipment, plant building design supplier quality assurance and pest control. These concepts are well-developed and have employed by the food industry for many years. Some examples of these practices and procedures are the quality of the water, raw material and ingredients, raw material reception and storage, procedure for dealing with consumer and/or importer complaints, equipment sanitation project, instrument calibration, periodic employee training, and others (Wallace & Williams, 2001).

Success in the implantation of GMP depends on managerial support, specialisation and motivation of the personnel, provision of resources and divulgation of the programme. Industries that have adopted the GMP programme have obtained the following results, amongst others:

- Better quality, safer products, decrease in incidence of consumer complaints.
- Better, more agreeable, cleaner and safer working environment.
- Greater employee motivation and productivity and improved psychological conditions.

Although the GMP programme provides the basic aspects of food safety, it should not be used as the only safety programme, since it is too generalised to indicate specific product hazards, gives equal importance to the diverse product in the processing line and does not establish control limits or corrective actions in the case of non-conformity. One of the main difficulties encountered by food industries in the implantation of GMP, especially in produce plants, is the lack of personnel specialised for this application.

The adoption of GMP in a production unit of minimally processed vegetables follows the norms traditionally used in other food industries, although specificities related to the process according to the type of product being produced should be respected. In general terms the following steps are fundamental in a good manufacturing practices implementation programme for products of this type: control of the operations as expressed by the temperatures of the processing plant; control of the water using in product washing and sanitization; contact time and concentration of the sanitizer used in the process; sanitation programme for the cutting utensils used; personal hygiene of the handlers and of the air in the processing line; raw material inspection, which frequently requires the existence of a metal detector; prevention of cross contamination; control of final product storage temperature; pest control and instrument calibration programme. It is important to emphasise that the programme must be developed according to the reality of the processing unit and that special attention should be paid to the washing-sanitization binomial and the quality of the water used. According to Leitão (1981), cited by Berbari, Paschoalino, and Silveira (2001), the observed reduction in microbial count should not be attributed solely to the action of the sanitizer but to the synergistic effect of this together with the good quality of the water used in the washing step. Simons and Sanguansri (1997) reported that the washing system to be adopted by a production unit may be more efficient if carried out with agitation, providing perfect mixing of the product washing water and increasing surface contact. The product structure should also be considered, since a milder wash should be applied to fragile delicate products, such as broccoli and lettuce, so as to avoid physical damage. Independent of the sanitizer used, monitoring of parameters such as contact time and concentration used is crucial, to avoid unexpected results. Researches have shown the viability of applying diverse sanitizers, alone or in combinations, in minimally processed vegetable lines (Berbari *et al*., 2001; Delaquis, Fukumoto, Toinoven, & Cliff, 2004; Garcia, Mount Junior, & Davidson, 2003; Sapers & Simmons, 1998) allied to extrinsic parameters, such as low temperatures. Preliminary studies should be carried out by qualified personnel to determine the best combination of parameters for the sanitizer(s) to be used in the production units, taking the regional characteristics of the cultivars into account. Research have reported improvement in the hygiene-sanitary performance of vegetable minimal processing lines after implementing a GMP programme (Matinéz--Tomé, Vera, & Murcia, 2000), demonstrating the viability of its application for product safety assurance.

Sanitation standard operating procedures (SSOP)

Like GMP, sanitation standard operating procedures (SSOP) are also included in the pre-requisite programs category. They play complete description of the specific activities required to maintain the utensils free of pathogenic microorganisms and with the deteriorative flora minimized, consequently avoiding contamination of the food when in contact with these utensils and installations. Contamination occurs when biological, chemical or physical agents present in the processing environment are incorporated into the food during handling (Setiabuhdi, Theis, & Norback, 1998). The first step of sanitization is the pre-wash, with the objective of removing gross dirt, followed by alkaline and acid washing (to remove proteins, carbohydrates, lipids and minerals, respectively). Disinfection is the elimination of pathogenic flora and minimization of the deteriorative flora, and can only be carried out after the utensils and installations are completely clean. Disinfection will not be effective if the former stage was not efficient. In order that sanitization be successful, the cleaning stage must be equally effective. Sanitization programmes should be considered as not only responsible for food safety, but also as an extension of the concern for public health. SSOP is a plan projected to prevent direct and indirect contamination of food products. It should include (Giese, 1991):

- A description of all the operational procedures for sanitization administered by the establishment.
- The specification and frequency of the procedures.
- Identification of the individual(s) responsible for the implementation and monitoring of the SSOP.
- The signature and date of the individual with authority and implementation when adopted or modified.

Since 1997, SSOP are obligatory in the USA for meat and poultry industries, as part of the pathogen reducing programme and implementation of HACCP. Cold storage units should develop SSOP for all the routine sanitization operations, before and after the operations, preventing direct contamination or adulteration of the products, the procedures being specific and detailed for each production line according to the needs of each operation, and should be up-dated with each change in the factory. As a general rule, they should not be included in the company HACCP plan, since the former control food safety risks associated with the plant environment (for example, installation maintenance and employee hygiene), whereas HACCP is effectively applied to the risks related to the step by step characteristics of product processing. The following central directives of SSOPs have been raised, considering the potential sources of contamination (Figueredo, 1999):

- Cross contamination of raw to cooked products, for example by surface contact with contaminated foods.
- Contact of product with non-potable water (e.g. condensation on exposed products) or other insalubrious substances.

- Contact with non-food substances (e.g. pesticides).
- Contact with substances transported by air.
- Handler diseases or inadequate hygiene.
- Foreign bodies in the food.
- Pests.

SSOPs are fundamental to quality assurance in minimally processed vegetable producing units, since they create registers of the fundamental activities in the control of the innocuousness of the process, guaranteeing success in the standardisation of the activities and providing conditions for traceability if some abnormality occurs. They should thus be implemented together with the GMP programme. However, as with all quality assurance programmes, it is important to mention that a technician should manage their implementation with knowledge in food science and microbiology.

Hazard analysis and critical control points (HACCP)

The HACCP system is a science-based system created to identify specific hazards and actions to control them in order to ensure food safety. It can be considered as efficient tool for both food industry and health authorities to prevent foodborne diseases (Vela & Fernandez, 2003).

HACCP identifies the potential avenues of contamination; establishes control measures to eliminate or minimize these hazards; monitors and documents the effectiveness of the program. This system provides a more specific and critical approach to the control of the hazards than achievable by traditional inspection and quality control procedures (International Fresh-Cut Produce Association, 1999).

The HACCP system includes a series of inter-related steps, inherent to industrial food processing, including all the operations occurring from production to consumption of the food (Castro, Schmidt, & Leitãno, 2002). The system centres its attention on critical operations in which control is essential, differing from the traditional inspection control, directed mostly at factors of an aesthetic nature or attending norms that frequently have no significance with respect to public health. In this way, one avoids the false sensation of safety frequently associated with inspections, in which dangerous practices are frequently not detected during the brief infrequent visits. An HACCP System should be developed for every food production line and adapted for the individual products and processes. Useful guides containing generic plans are available, which can aid in the development of plans and processes.

The HACCP plans for minimally processed vegetables are well established and have been used successfully by processors for years, being based on the same seven principles and risk categories common in the control of meat, poultry and fish. These principles are conducted in the following order: (1) conduct a hazard analysis; (2) determine the critical control points; (3) establish the critical limits; (4) establish monitoring procedures; (5) establish corrective actions; (6) establish verification procedures and (7) establish record-keeping and documentation procedures. It is important to remember that HACCP plans for minimally processed vegetables have no thermal death phase for the destruction of pathogenic microorganisms, making adoption of the plan even more important (Howard & Gonzalez, 2001). The use of low temperatures as a critical control point has been questioned, since psychrophiles such as *L. monocytogenes* can grow at temperatures as low as 5 °C (Delea, 2001).

Taylor (2001) reported additional difficulties that may be encountered in the implementation of the HACCP system in minimally processed vegetable lines. The majority are small to medium sized operations, employing just a few workers who accumulate many tasks and have no knowledge of food safety. Thus, implementation of the system may be tedious and confusing and associated with ‘loss of time’ and ‘generation of excess paper’, since the existing literature is directed to larger companies with totally different realities. Training takes a week and signifies a halt in the production line. As a possible solution, the author recommends short courses and the identification of the critical points essential for the process, together with simple experiments to validate them, such as checking the time and temperature, the system being verified more frequently by personnel from the regulatory organs. Indeed, the establishment of partnerships with the various spheres of the Sanitary Surveillance System is very important, or otherwise with private entities that could actively help to implement the system and elaborate material adapted to the reality of the production unit. They could also organise shorter training sessions focussed exclusively on the hazards related to the minimal processing of vegetables, and carry out an uninterrupted programme aimed at awareness of the advantages of adopting the system.

Prospectives

Minimally processed vegetables are constantly increasing their participation in the diet, be it for social reasons, such as, for example, a healthy diet and consequent maintenance of good health, or for economic reasons, as a result of the constantly increasing insertion of women in the work force, leading to a preference for highly practical industrialised foods, without losing the fresh attribute. For these reasons, the adoption of Assurance Quality Systems by the production units is extremely important, to preserve the health of those who consume the products who present diverse levels of sensitivity. Specific legislation for these products is also necessary, still non-existent in most developing countries, which implies in the existence of specific microbiological standards and technical regulations for good agricultural practices and good manufacturing practices, including the sanitation standard operating procedures. Implementation of the HACCP system to be carried out at a later stage, should be accompanied by specific strategies appropriate for the reality of these establishments, resulting in the smallest possible number of critical points so as to make the operation viable, in addition to external support to verify the feasibility of the operation. In this way, it should be possible to implement a quality assurance system into the process, resulting in a safe product with no risks to public health.

References

Abdul-Rauof, U. M., Beuchat, L. L. R., & Ammar, M. S. (1993). Survival and growth of *Escherichia coli* O:157:H7 on salad vegetables. *Applied and Environmental Microbiology, 59*(7), 1999–2006.

Allende, A., Aguayo, E., & Artes, F. (2004). Microbial and sensory quality of commercial fresh processed red lettuce throughout the production chain and shelf life. *International Journal of Food Microbiology, 91*, 109–117.

Arts, AM. (2001). Initiatives for food safety in the fresh produce industry in New Zealand. *Food Technology in New Zealand*, June/July.

Berbari, S. A. G., Paschoalino, J. E., & Silveira, N. F. A. (2001). Efeito do cloro na água de lavagem para desinfecção de alface minimamente processada. *Ciência e Tecnologia de Alimentos, 21*(2), 197–201.

Beuchat, L. R. (1999). Survival of enterohemorrhagic *Escherichia coli* O157:H7 in bovine feces applied to lettuce and the effectiveness of chlorinated water as a disinfectant. *Journal of Food Protection, 62*(8), 845–849.

Castro, M. F. P. M. de, Schmidt, F. L., & Leitão, M.F.de.F. (2002). Boas Práticas Agrícolas e Aplicação do Sistema APPCC no cultivo e processamento industrial do café obtido pela via seca. *Higiene Alimentar, 16*(96), 29–42.

Delaquis, P. J., Fukumoto, L. R., Toivonen, P. M. A., & Cliff, M. A. (2004). *Postharvest Biology and Technology, 31*(1), 321–347.

Delea, S. (2001). Produce safety and the potential for foodborne disease: A public health analysis. *Hortscience, 36*(1), 25–28.

De Roever, C. (1998). Microbiological safety evaluations and recommendations on fresh produce. *Food Control, 9*(6), 321–347.

Drofener, M. L., & Brinton, W. F. (1995). Survival of *E. Coli* and Salmonella populations in aerobic thermophilic composts as measured with DNA gene probes. *Zentralblatt fur Hygiene, 197*, 387–397.

Fain, R. F. (1996). A review of the microbiological safety of fresh salads. *Dairy Food and Environmental Sanitation, 16*(3), 146–149.

Figueredo, R. M. (1999). *SSOP—Padrões e Procedimentos Operacionais de Sanitização coleção Higiene de Alimentos*, Vol. 1. São Paulo: Câmara Brasileira do Livro.

Francis, G. A., Thomas, C., & O'Beirne, D. (1999). The Microbiological safety of minimally processed vegetables. *International Journal of Food Science and Technology, 34*, 1–22.

Garcia, A., Mount, J. R., & Davidson, P. M. (2003). Ozone and chlorine treatment of minimally processed lettuce. *Journal of Food Science, 68*(12), 2474–2551.

Giese, J. H. (1991). Sanitation: The key to food safety and public health. *Food Technology, 45*(12), 74–80.

Gonçalo, E. B. (2003). Certificação de sistemas de qualidade na indústria de laticínios. *Revista do Instituto de Laticinios Cândido Tostes, 58*(333), 9–14.

Howard, L. R., & Gonzalez, A. R. (2001). Food safety and produce operation: What is the future? *Hortscience, 36*(1), 33–39.

Hurst, W. C. (1995). Sanitation of lightly processed fruits and vegetables. *Hortscience, 30*(1), 22–24.

International Fresh-Cut Produce Association. (1999). Food safety guidelines for the fresh-cut produce industry. 125 pp.

Kirby, R. M., Bartram, J., & Carr, R. (2003). Water in food production and processing: Quantity and quality concerns. *Food Control, 14*(5), 283–289.

Matinéz-Tomé, M., Vera, A. M., & Murcia, M. A. (2000). Improving the control of food production in catering establishments with particular reference to the safety of salads. *Food Control, 11*(6), 437–445.

Oliveira, A.M. de, & Masson, M. L. (2003). Terminologia e definições utilizadas nos sistemas de qualidade e segurança alimentar. *Boletim da Sociedade Brasileira de Ciência e Tecnologia de Alimentos, 37*(1), 52–57.

Pabrua, F. P. (1999). Good agricultural practices: Methods to minimize microbial risk. *Dairy, Food and Environmental Sanitation, 19*(7), 523–526.

Reyes, V. G. (1996). Improved preservation systems for minimally processed vegetables. *Food in Australia, 48*(2), 87–90.

Salleh, N. A., Rusul, G., Hassan, Z., Reezal, A., Isa, S. H., Nishibuchi, M., & Radu, S. (2003). Incidence of *Salmonella spp.* in raw vegetables in Selangor, Malaysia. *Food Control, 14*, 475–479.

Sapers, G. M., & Simmons, G. F. (1998). Hydrogen peroxide disinfection of minimally processed fruits and vegetables. *Food Technology, 52*(2), 48–52.

Seaton, L. (2001). Retailers assured by produce schemes. *Fresh produce Journal*, Summer Suppl.

Setiabuhdi, M., Theis, M., & Norback, J. (1998). Integrating hazard analysis and critical point (HACCP) and sanitation for variable food safety. *Journal of the American Dietetic Association, 97*(8), 889–891.

Simons, L. K., & Sanguansri, P. (1997). Advances in washing of minimally processed vegtables. *Food Australia, 49*(2), 75–80.

Sivapalasingam, S., Friedman, C. R., Cohen, L., & Tauxe, R. V. (2004). Fresh-produce: A growing cause of outbreaks of foodborne illness in the United States, 1973 through 1997. *Journal of Food Protection, 67*(10), 2342–2353.

Solomon, E. B., Potenski, C. J., & Mattews, K. R. (2002a). Effect of irrigation method on transmission to and persistence of *E. coli* 0157:H7. *Journal of Food Protection, 65*(4), 673–676.

Solomon, E. B., Yaron, S., & Mattews, K. R. (2002b). Transmission of *Escherichia coli* O157:H7 from contaminated manure and irrigation water to lettuce plant tissue and its subsequent internalisation. *Applied and Environmental Microbiology, 68*(1), 397–400.

Taylor, E. (2001). HACCP in small companies: benefit or burden? *Food Control, 12*, 217–222.

US Departament of Health and Human Services, Food and Drug Administration-FDA & Center for Food Safety and Applied Nutrition-CFSAN. (1998). Guide to minimize microbial food safety hazards for fresh fruits and vegetables. 39 pp.

Vela, A. R., & Fernandez, J. M. (2003). Barriers for the development and implementation of HACCP plans: Results from a Spanish regional survey. *Food Control, 14*(5), 333–337.

Wallace, C., & Williams, T. (2001). Pre-requisites: A help or a hindrance to HACCP? *Food Control, 12*(12), 235–240.

Wiley, R. C. (1994). *Minimally processed refrigerated fruits and vegetables*. London: Chapman & Hall.