

**Minimally Processed Fruit**

**5.0 Minimally Processed Fruit  
Food Safety Risk Assessment**

***DRAFT***

Food Inspection Branch  
Food Industry Division  
Ontario Ministry of Agriculture and Food

## 5.0 Minimally Processed Fruit - Food Safety Risk Assessment

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Pre-Processing</b></p> <p><b>Facility Location and Design</b></p> <p>The process of building the processing facility in a specific location and designing it's structure and equipment.</p>	<p><b>Biological</b></p> <p>Concern that potential sources of contamination might make a location less suitable for a processing operation. Environmentally polluted areas, areas subject to flooding, areas prone to infestations of pests or areas where wastes can not be effectively removed do not provide suitable conditions for a processing operation. Also, the concern that the structure of the facility, equipment and food contact surfaces might promote microbial growth and make effective sanitizing more difficult. Cracks and crevices in wall and counters can provide harborage for rodents, insects and pathogens. Enclosed areas of equipment can be difficult to clean properly. Rust spots also provide a place of attachment for pathogens (183).</p>	<p>Nglg-Med</p> <p>The likelihood of fruit becoming contaminated due to a poor facility location or improper design of the facility or processing equipment is considered quite low. Effective cleaning and sanitizing of equipment and processing area reduce the likelihood that contamination of fruit will result. However, if problem areas are not recognized and dealt with properly, the risk of contamination can be as high as medium.</p>	<p>Nglg-Med*</p> <p>If contamination of the fruit occurred at this stage, the probability that the pathogens would survive through to consumption is extremely low. Pathogens are reduced by environmental degradation, washing and processing steps such as peeling. If the outer surface of the fruit is removed in processing the likelihood of exposure is reduced. A study was done that showed that bacterial contamination can be reduced through washing and peeling produce (183, 195).</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High  If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immuno-compromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).	Low-Med  Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).	Nglg  Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.	Low  No incidences have been identified but there is some data indicating that improperly designed equipment can lead to contamination of food. This provides reasonable certainty of assessment.	Nglg-Med*  The probability of contamination and exposure at this stage are variable. The impacts of contamination are fairly low. While there is some uncertainty the overall risk is expected to be mostly low.	When deciding where to locate the facility, take into account environmental factors mentioned. Before deciding on equipment and food contact surfaces, consult a resource for sanitary plant and equipment design (Code of Practice or IFPA , Food Safety Guidelines for the Fresh-cut Produce Industry).

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<p><b>Pre-Processing</b></p> <p><b>Facility Location and Design</b></p> <p>The process of building the processing facility in a specific location and designing it's structure and equipment.</p>	<p><b>Chemical</b></p> <p>The concern that improper facility design will promote chemical contamination of food. If food contact surfaces are absorptive or pitted or there isn't proper drainage, ventilation or lighting in the food processing area, it can lead to contamination of fruit with sanitizers used to clean the equipment. If equipment is not proper food grade material it might leach chemicals into the fruit.</p>	<p>Nglg-Low</p> <p>The probability that fruit will be contaminated with chemicals because of improper facility design is considered negligible. If manufacturer's directions are followed, sanitizers should not be found in high enough concentration on the equipment to significantly contaminate the fruit.</p>	<p>Nglg-Low*</p> <p>If fruit becomes contaminated environmental degradation of chemicals and washing prior to consumption reduce the risk of consumer exposure to chemicals. If contaminated fruit is consumed, the probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Low	Nglg	Low-Med	Nglg-Low*	<p>To reduce risk: Before deciding on equipment and food contact surfaces, consult a resource for sanitary plant and equipment design (Code of Practice or IFPA , Food Safety Guidelines for the Fresh-cut Produce Industry).</p>
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>While it is known that some surfaces are easier to sanitize than others and that some materials will retain a sanitizer it is not well known what the effect of this is on the food being processed on these surfaces.</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

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<p><b>Pre-Processing</b></p> <p><b>Facility Location and Design</b></p> <p>The process of building the processing facility in a specific location and designing its structure and equipment.</p>	<p><b>Physical</b></p> <p>The concern that improper facility design will lead to physical contamination of the fruit. If lighting is not properly shielded, broken glass may contaminate the fruit. If lighting is insufficient it will prevent effective identification and removal of any physical hazards that might be present. If equipment is not designed properly it can lead to contamination of fruit with loose nuts or rivets.</p>	<p>Nglg-Low</p> <p>The probability of any physical extraneous material contaminating the edible product is negligible. Fruit is unlikely to incorporate physical material into its structure.</p>	<p>Nglg-Low*</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is extremely low. The physical contamination is likely to be noticed and removed during the processing of the product.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

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Nglg-Med	Nglg-Low	Nglg	Low	Nglg	To reduce risk: Before deciding on equipment and food contact surfaces, consult a resource for sanitary plant and equipment design (Code of Practice or IFPA , Food Safety Guidelines for the Fresh-cut Produce Industry).
If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).	If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.	Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.	No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.	Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.	

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<p><b>Pre-Processing</b></p> <p><b>Receiving and Storage</b></p> <p>This includes the process of transferring the fruit from the transport vehicle to the processing facility, a preliminary inspection of the product as it arrives and storage of the product at appropriate temperatures. If processing is being carried out within a retail establishment, the fruit might already be on site and only need to be transferred from storage or retail shelves to the processing area.</p>	<p><b>Biological</b></p> <p>Concern that fruit will become contaminated during receiving, inspection and storage, through contact with contaminated surfaces or equipment, a dirty receiving or storage area, pests or any other environmental factor contacting the product. Food can also become contaminated by infected workers. Between 1975 and 1998 there were 81 outbreaks involving 16 different pathogens associated with food contaminated by workers. (187, 192) Proper temperature control is important at this stage to minimize the growth of any existing pathogens. A number of outbreaks of Salmonella in cut melons have been attributed to improper storage temperatures following contamination (188, 189, 190).</p>	<p>Nglg-Low</p> <p>Usually, during shipping, receiving and storage, fruit will be packed into crates, which minimizes the opportunity for contamination. Although localized contamination may occur, it is not likely to be widespread. If fruit is manually inspected the risk of contamination increases because of the fruits' exposure to humans and the environment.</p>	<p>Nglg-Low</p> <p>If contamination of the fruit occurred at this stage, the probability that the pathogens would survive through to consumption is extremely low. Pathogens are reduced by environmental degradation, washing and processing steps such as peeling. If the outer surface of the fruit is removed in processing the likelihood of exposure is reduced. A study was done that showed that bacterial contamination can be reduced through washing and peeling (183,195). If temperature abuse occurs it can promote the growth of existing pathogens thereby increasing the risk of exposure (196).</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

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Low-High  If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immunocompromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).	Low-Med  Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).	Nglg  Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.	Low-Med  While no incidents have been directly attributed to the incoming product stage, a number of outbreak cases have been attributed to improper handling techniques which are issues for the incoming product and this provides reasonable certainty of assessment.	Nglg-Low*  Although the impact is variable and specific data are limited, the probabilities of contamination and exposure are very low. Therefore it is reasonably certain that the overall risk is negligible.	To reduce risk: Keep receiving area and transport vehicles clean. Know the other uses of the vehicle and understand the potential for foodborne pathogens on other products shipped in the same vehicle. Maintain temperatures below 4°C during transport and receiving when possible and minimize the amount of time the fruit is out of cold storage. Exclude any ill workers from the facility or at least from contact with food.

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<p><b>Pre-Processing</b></p> <p><b>Receiving and Storage</b></p> <p>This includes the process of transferring the fruit from the transport vehicle to the processing facility, a preliminary inspection of the product as it arrives and storage of the product at appropriate temperatures.</p>	<p><b>Chemical</b></p> <p>Concern that the incoming product is contaminated with chemicals or of contamination from climate control equipment, cleaners or sanitizers or contact surfaces in the transport vehicle or in the receiving and storage area. It is important that the facility be designed with storage areas for chemicals separate from food processing areas.</p> <p>While the level of chemicals in food is generally quite low it had been suggested that foods are a source of exposure to chemicals (35, 36).</p>	<p>Nglg</p> <p>No previous issues have been identified. Fruit will normally be in boxes for transport and storage and this will minimize the opportunity for contact with chemicals. Although not likely, localized contamination could occur. Widespread contamination is highly unlikely. The probability of chemicals being present at levels higher than is allowed is negligible.</p>	<p>Nglg</p> <p>If fruit becomes contaminated environmental degradation of chemicals and washing prior to sale reduce the risk of consumer exposure to chemicals. The risk of exposure is considered negligible. If contaminated fruit is consumed, the probability of significant human exposure varies with the chemical and the individual (39, 40, 44).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

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Nglg-Med	Low	Nglg	Low	Nglg	<p>To reduce risk:            Require that vendors follow GAPs (12). Monitor the use of all chemicals that could potentially contact the fruit during transport and receiving. Use only products registered for cleaning and sanitizing in the transport vehicle and receiving and storage area. Follow label recommendations. There should be a storage area for chemicals separate from the fruit processing area.</p>
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

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<p><b>Pre-Processing</b></p> <p><b>Receiving and Storage</b></p> <p>This includes the process of transferring the fruit from the transport vehicle to the processing facility, a preliminary inspection of the product as it arrives and storage of the product at appropriate temperatures.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg</p> <p>The probability of any physical extraneous material contaminating the edible product is negligible. Fruit is unlikely to incorporate loose physical material into its structure. Fruit in packages is less likely to become contaminated.</p>	<p>Nglg</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is extremely low. The contamination should be noticed during processing stages and removed. If a metal detector is used in the processing line, the likelihood of exposure is reduced.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

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Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
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Nglg-Med	Nglg-Low	Nglg	Low	Nglg	To reduce risk: Clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).
If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).	If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.	Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.	No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.	Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.	

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<p><b>Pre-Processing</b></p> <p><b>Product Preparation</b></p> <p>This stage involves sorting, trimming and washing of the product in preparation for processing.</p>	<p><b>Biological</b></p> <p>Concern that fruit will become contaminated through contact with infected workers Between 1975 and 1998 there were 81 outbreaks involving 16 different pathogens associated with food contaminated by workers. (187, 192) Contaminated water and equipment can also be a source of contamination (15, 24, 76, 84, 86). Incomplete washing of the fruit can also lead to contamination. Pathogens normally found on the surface of the fruit can be transferred to the flesh through trimming (186, 188, 189, 190, 191).</p>	<p>Low-Med</p> <p>The extra steps involved in minimally processed commodities and the increased handling make contamination more likely. If sorting is done manually, contamination from infected workers is more likely. If equipment used to trim fruit and food contact surfaces are not properly sanitized, it can lead to contamination of the fruit. If water used to wash the fruit does not contain a sanitizer or is recycled the risk of contamination increases.</p>	<p>Nglg-Low</p> <p>If contamination of the fruit occurred at this stage, the probability that the pathogens would survive through to consumption is very low. Pathogens are reduced by environmental degradation, washing and processing steps such as peeling. If the outer surface of the fruit is removed in processing the likelihood of exposure is reduced. A study was done that showed that bacterial contamination can be reduced through washing and peeling of produce (183, 195).</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

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Low-High	Low-Med	Nglg	Nglg-Low	Low	<p>To reduce risk: Use potable water whenever possible (62). Periodically test the quality of the water especially where water is recycled. Exclude any ill workers from contact with food. Ensure that all equipment is properly sanitized before using it in processing. Fruit should be washed thoroughly to prevent spreading contamination from the outer surface to the flesh during trimming.</p>
<p>If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immuno-compromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).</p>	<p>Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).</p>	<p>Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.</p>	<p>A number of outbreak cases have been traced back to infected food handlers as the source of contamination (192). Cases of foodborne illness have been traced back to fruit cut on the same surface as raw meat (189). Studies have been done to demonstrate that cutting through a contaminated rind or peel can spread contamination to the flesh (186, 188, 189, 190, 191). This information provides good certainty of assessment.</p>	<p>The impact is variable but the risk of contamination and exposure are slightly higher at this stage. There are a number of outbreaks and studies that support these ratings and therefore the overall risk is expected to be quite low.</p>	

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<p><b>Pre-Processing</b></p> <p><b>Product Preparation</b></p> <p>This stage involves sorting, trimming and washing of the product in preparation for processing.</p>	<p><b>Chemical</b></p> <p>The concern that fruit will become chemically contaminated during preparation. This could occur if sanitizers used on trimming and sorting equipment are not properly rinsed off or if levels of sanitizers in wash water are above the recommended concentration. While the level of chemicals in food is usually quite low. It has been suggested that foods are a potential source of exposure to chemicals (35, 36).</p>	<p>Nglg</p> <p>The risk of fruit becoming contaminated with chemicals at this stage is considered negligible. If sanitizer directions are followed than chemical residues should not be found on processing equipment or in water.</p>	<p>Nglg</p> <p>If fruit becomes contaminated environmental degradation of chemicals and further processing and washing steps should serve to reduce the amount of chemical found on the fruit. The risk of exposure is considered negligible. If contaminated fruit is consumed, the probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans..</p>

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Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
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Nglg-Med	Low	Nglg	Low	Nglg	To reduce risk: Monitor the use of all chemicals that could potentially contact the fruit during product preparation. Use only products registered for cleaning and sanitizing processing equipment. Follow label recommendations.
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

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<p><b>Pre-Processing</b></p> <p><b>Product Preparation</b></p> <p>This stage involves sorting, trimming and washing of the product in preparation for processing.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg</p> <p>The probability of any physical extraneous material contaminating the edible product is negligible. Fruit is unlikely to incorporate loose physical material into its structure.</p>	<p>Nglg</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is extremely low. The contamination should be noticed during processing stages and removed. If a metal detector is used in the processing line, the likelihood of exposure is reduced.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

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Nglg-Med	Nglg-Low	Nglg	Low	Nglg	<p>To reduce risk: Keep all equipment guards in place, clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).</p>
<p>If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).</p>	<p>If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.</p>	<p>Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.</p>	<p>No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

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<p><b>Processing</b></p> <p><b>Cutting, Slicing, Shredding, Grinding</b></p> <p>This is the major processing stage where the product is converted from whole product to processed product through any number of processes. This can be done mechanically or by hand.</p>	<p><b>Biological</b></p> <p>Concern that fruit will become contaminated through contact with infected workers. Between 1975 and 1998 there were 81 outbreaks involving 16 different pathogens associated with food contaminated by workers. (187, 192) Contaminated equipment can also be a source of contamination. (183). Cross contamination of fruit from other commodities can also occur. A number of outbreaks of both Salmonella and E. coli associated with cut fruit have been attributed to the fruit being cut on the same surface as raw meat (188, 189, 190, 191). Incomplete washing of the fruit can also lead to contamination. Pathogens normally found on the surface of the fruit can be transferred to the flesh through trimming (186, 188, 189, 190, 191).</p>	<p>Low-Med</p> <p>The extra steps involved in minimally processed commodities and the increased handling make contamination more likely. If processing is done manually, contamination from infected workers is more likely. If equipment used to process fruit and food contact surfaces are not properly sanitized, it can lead to contamination. If fruit is not properly washed, pathogens normally found on the surface of the fruit can be transferred to the flesh through processing (186, 188, 189, 190, 191). When fruit cells are damaged through processing a point of entry for pathogens is available and cellular contents provide a source of nutrients for pathogens (185).</p>	<p>Nglg-Low</p> <p>If contamination of the fruit occurred at this stage, the probability that the pathogens would survive through to consumption is very low. Pathogens are reduced by environmental degradation, and if the fruit is subsequently washed the likelihood of exposure is further reduced (183, 195).</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

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on human health	economic	environment			
Nglg-Med	Low	Nglg	Low	Nglg	<p>To reduce risk:            Monitor the use of all chemicals that could potentially contact the fruit during processing. Use only products registered for cleaning and sanitizing processing equipment. Follow label recommendations. Maintain processing equipment that might contact fruit.</p>
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Processing</b></p> <p><b>Cutting, Slicing, Shredding, Grinding</b></p> <p>This is the major processing stage where the product is converted from whole product to processed product through any number of processes. This can be done mechanically or by hand.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg-Low</p> <p>If fruit is processed and packaged mechanically the risk of physical contamination increases. If pieces of machinery fall into the fruit they are less likely to be noticed and removed before packaging. However the likelihood of this happening is quite low. The contamination may enter the package with fruit but the fruit is unlikely to incorporate physical material into its structure.</p>	<p>Nglg</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is extremely low. Any large extraneous material should be visible or felt by the consumer and subsequently removed prior to consumption. If a metal detector is used in the processing line, the likelihood of exposure is reduced.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Nglg-Low	Nglg	Low	Nglg	<p>To reduce risk: Keep all equipment guards in place, clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).</p>
<p>If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).</p>	<p>If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.</p>	<p>Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.</p>	<p>No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Processing</b></p> <p><b>Washing, Rinsing, Drying, Blending</b></p> <p>After the major processing steps the product might be washed or rinsed and then dried and combined with other commodities to be packaged.</p>	<p><b>Biological</b></p> <p>Concern that fruit will become contaminated through contact with infected workers Between 1975 and 1998 there were 81 outbreaks involving 16 different pathogens associated with food contaminated by workers. (187, 192) Water and equipment can also be sources of contamination.</p>	<p>Nglg-Low*</p> <p>The extra steps involved in minimally processed commodities and the increased handling make contamination more likely. If processing is done manually, contamination from infected workers is more likely. If equipment used to process fruit and food contact surfaces are not properly sanitized, it can lead to contamination of the fruit. If water used to wash the fruit does not contain a sanitizer or is recycled the risk of contamination increases. If the processing of fruit is effectively kept separate from the processing of raw meat products, the risk of contamination is reduced.</p>	<p>Low-Med</p> <p>If contamination of the fruit occurred at this stage, the risk of pathogens surviving through to consumption is slightly more likely because of the reduced time to consumption and the fact that this is the last processing step. If the fruit is not washed again before consumption, likelihood of exposure is increased. If temperature abuse occurs, pathogen growth will be accelerated and consumer exposure is more likely (196).</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High  If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immunocompromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).	Low-Med  Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).	Nglg  Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.	Low  A number of outbreak cases have been traced back to infected food handlers as the source of contamination. There have not been any incidences directly associated with this processing step. However, it is known that water and equipment can act as vectors for pathogens. This data provides reasonable certainty of assessment.	Low  The impact is variable but the risk of contamination and exposure are slightly higher at this stage. There are a number of outbreaks and studies that support these ratings and therefore the overall risk is expected to be low.	To reduce risk: Exclude any ill workers from contact with food. Ensure that all equipment is properly sanitized before using it in processing. Fruit should be washed thoroughly to prevent spreading contamination from the outer surface to the flesh during trimming.  Use potable water whenever possible (62). Periodically test the quality of the water especially where water is recycled.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Processing</b></p> <p><b>Washing, Rinsing, Drying, Blending</b></p> <p>After the major processing steps the product might be washed or rinsed and then dried and combined with other commodities to be packaged.</p>	<p><b>Chemical</b></p> <p>The concern that fruit will become chemically contaminated during preparation. This could occur if sanitizers used on processing equipment are not properly rinsed off or if levels of sanitizers in wash water are above the recommended concentration. While the level of chemicals in food is usually quite low. It has been suggested that foods are a potential source of exposure to chemicals (35, 36).</p>	<p>Nglg-Low*</p> <p>The risk of fruit becoming contaminated with chemicals at this stage is considered negligible. If sanitizer directions are followed than chemical residues should not be found on processing equipment or in water.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, consumer exposure is slightly more likely because of reduced time until consumption and the fact that this is the last processing stage. The fruit is not likely to be washed again before consumption. The risk of exposure is considered negligible to low. If contaminated fruit is consumed, exposure is likely to occur. The probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Low	Nglg	Low	Nglg-Low*	To reduce risk: Monitor the use of all chemicals that could potentially contact the fruit during processing. Use only products registered for cleaning and sanitizing processing equipment or products for use in fruit wash water. Follow label recommendations.
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Processing</b></p> <p><b>Washing, Rinsing, Drying, Blending</b></p> <p>After the major processing steps the product might be washed or rinsed and then dried and combined with other commodities to be packaged.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg-Low</p> <p>If fruit is processed and packaged mechanically the risk of physical contamination increases. If pieces of machinery fall into the fruit they are less likely to be noticed and removed before packaging. However the likelihood of this happening is quite low. The contamination may enter the package with fruit but the fruit is unlikely to incorporate physical material into its structure.</p>	<p>Nglg</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is extremely low. Any large extraneous material should be visible or felt by the consumer and subsequently removed prior to consumption. If a metal detector is used in the processing line, the likelihood of exposure is reduced.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Nglg-Low	Nglg	Low	Nglg	<p>To reduce risk: Keep all equipment guards in place, clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).</p>
<p>If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).</p>	<p>If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.</p>	<p>Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.</p>	<p>No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Packaging</b></p> <p>This stage involves moving the product to the packaging area and putting the fruit or fruit mixture into some sort of package for retail sale. The packaging might be done mechanically or by hand. Modified atmosphere packaging (MAP) is used with a lot of fresh cut produce to extend the shelf life of the product.</p>	<p><b>Biological</b></p> <p>The concern that fruit will become contaminated through the use of dirty packaging material or contact with infected workers. Between 1975 and 1998 there were 81 outbreaks involving 16 different pathogens associated with food contaminated by workers. (187, 192) Certain types of MAP packaging can promote the growth of pathogens. Improper temperature control at this stage can lead to the accelerated growth of any existing pathogens. A number of outbreaks of Salmonella in cut melons have been attributed to improper storage temperatures following contamination (188, 189, 190, 196).</p>	<p>Nglg-Low</p> <p>Packaging serves to reduce the incidence of external contamination of the fruit. However, if the packaging itself is contaminated it can be spread to the fruit. If fruit is packaged by hand, contamination from infected workers is more likely.</p>	<p>Low-Med</p> <p>Since most minimally processed fruit is sold “ready to eat”, the risk of consumer exposure is higher because many products will be bought quickly and consumed as is with no further processing or washing. If MAP is used, it can extend the shelf life of the product but it can also promote the growth of certain pathogens by reducing natural competing microflora and extending the shelf life thereby allowing the pathogen to increase in numbers and increasing the risk of consumer exposure (*16, *17, 18). Other types of packing such as film packing, increase the relative humidity and decrease the oxygen levels and this can promote growth of pathogens and increase risk of exposure (197).</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High  If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immunocompromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).	Low-Med  Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).	Nglg  Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.	Low  A number of outbreak cases have been traced back to infected food handlers as the source of contamination. There have not been any incidences directly associated with this processing step. However, a number of outbreaks associated with minimally processed fruit have been influenced by improper storage temperatures. This data provides reasonable certainty of assessment.	Low  The impact is variable but the risk of contamination and exposure are slightly higher at this stage. There are a number of outbreaks and studies that support these ratings and therefore the overall risk is expected to be low.	To reduce risk: Ensure that packaging material is new and clean and stored in a proper location to prevent contamination. Exclude any ill workers from contact with food. Keep fruit at temperatures below 4°C as much as possible. Be aware of the various effects modified atmosphere packaging can have on microbial populations. Reflect this in the best before date.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Packaging</b></p> <p>This stage involves moving the product to the packaging area and putting the fruit or fruit mixture into some sort of package for retail sale. The packaging might be done mechanically or by hand. Modified atmosphere packaging (MAP) is used with a lot of fresh cut produce to extend the shelf life of the product.</p>	<p><b>Chemical</b></p> <p>The concern that fruit will become chemically contaminated during packaging. This could occur through contaminated packing material or contact with cleaners and sanitizers used in the packing area. While the level of chemicals in food is usually quite low. It has been suggested that foods are a potential source of exposure to chemicals (35, 36).</p>	<p>Nglg</p> <p>Chemicals are not used during packaging. The risk of fruit becoming contaminated with chemicals at this stage is considered negligible.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, consumer exposure is unlikely but possible. Short time until consumption and the fact that the fruit is not likely to be washed before consumption increase the likelihood of exposure. The probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
<p>Nglg-Med</p> <p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Low</p> <p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>Nglg</p> <p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>Low</p> <p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40)..</p>	<p>Nglg</p> <p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	<p>To reduce risk: Monitor the use of all chemicals that could potentially contact the fruit during packing. Use only products registered for use and follow label recommendations.</p>

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Packaging</b></p> <p>This stage involves putting the fruit or fruit mixture into some sort of package for retail sale. The packaging might be done mechanically or by hand. Modified atmosphere packaging (MAP) is used with a lot of fresh cut produce to extend the shelf life of the product.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg-Low</p> <p>If fruit is processed and packaged mechanically the risk of physical contamination increases. If pieces of machinery fall into the fruit they are less likely to be noticed and removed before packaging. However the likelihood of this happening is quite low. The contamination may enter the package with fruit but the fruit is unlikely to incorporate physical material into its structure.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is extremely low. Any large extraneous material should be visible or felt by the consumer and subsequently removed prior to consumption. If a metal detector is used in the processing line, the likelihood of exposure is reduced.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Nglg-Low	Nglg	Low	Nglg	<p>To reduce risk: Keep all equipment guards in place, clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).</p>
<p>If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).</p>	<p>If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.</p>	<p>Although no specific studies are known, the impact of physical hazards in any food on the environment is considered negligible.</p>	<p>No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Storage</b></p> <p>After packaging, the fruit might again be held in short term cold storage before shipping to retail outlets.</p>	<p><b>Biological</b></p> <p>Concern that fruit will become contaminated through contact with Pests, a dirty storage area or cross contamination from other fruit. Proper temperature control is important at this stage to minimize the growth of any existing pathogens. A number of outbreaks of Salmonella in cut melons have been attributed to improper storage temperatures following contamination (188, 189, 190, 196).</p>	<p>Nglg</p> <p>Now that fruit is individually packaged, the opportunity for external contamination or cross contamination is even lower. If contamination occurs it should be contained and localized.</p>	<p>Low-Med</p> <p>Since most minimally processed fruit is sold “ready to eat”, the risk of consumer exposure is higher because many products will be bought quickly and consumed as is with no further processing or washing. If temperature abuse occurs at this stage there is potential for growth of the pathogen, thereby increasing the risk of exposure (196). Significant consumer exposure depends on the number of pathogens present and the individual.</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High	Low-Med	Nglg	Low-Med	Nglg-Low	<p>To reduce risk: Control pests in areas where fruit is stored (53). Keep storage area clean and do not store fruit with other products that might cross contaminated it. Keep fruit stored at temperatures below 4°C. Maintain a temperature log of storage cooler temperatures.</p>
<p>If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immunocompromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).</p>	<p>Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).</p>	<p>Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.</p>	<p>There have not been any incidences directly associated with this processing step. However, a number of outbreaks associated with minimally processed fruit have been influenced by improper storage temperatures. This data provides reasonable certainty of assessment.</p>	<p>The risk of contamination is reduced at this stage but the risk of exposure is increased. The impact is variable and although specific data is limited the overall risk is expected to be mostly low.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Storage</b></p> <p>After packaging, the fruit might again be held in short term cold storage before shipping to retail outlets.</p>	<p><b>Chemical</b></p> <p>The concern that fruit may become chemically contaminated from climate control equipment, chemical sanitizers or cleaners. While the level of chemicals in food is usually quite low. It has been suggested that foods are a potential source of exposure to chemicals (35, 36).</p>	<p>Nglg</p> <p>Although localized contamination is possible, widespread contamination is not likely. Since fruit is in individual packages it is less likely to become contaminated. Chemicals are not commonly used in storage rooms while product is being stored.</p>	<p>Nglg-Low</p> <p>Chemicals are not used during packaging. However, if fruit becomes contaminated at this stage, consumer exposure is unlikely but possible. Reduced time until consumption and the fact that the fruit is not likely to be washed again before consumption increase the likelihood of exposure. The risk of exposure is considered negligible to low. If contaminated fruit is consumed, exposure is likely to occur. The probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Low	Nglg	Low	Nglg	To reduce risk: Monitor the use of all chemicals that could potentially contact the fruit during storage. Use only products registered for use and follow label recommendations.
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Storage</b></p> <p>After packaging, the fruit might again be held in short term cold storage before shipping to retail outlets.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48, 49). See Appendix C for a list of physical material hazards.</p>	<p>Nglg</p> <p>The probability of any physical extraneous material contaminating the edible product is negligible. Fruit is unlikely to incorporate loose physical material into its structure. At this stage the product is usually in a container and therefore physical contamination is even less likely.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is very low. Any large extraneous material should be visible and subsequently removed prior to consumption.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Nglg-Low	Nglg	Low	Nglg	To reduce risk: Clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).
If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).	If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.	Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.	No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.	Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Shipping, Transportation and Distribution</b></p> <p>Transport of packaged fruit from the processing operation to a retail outlet.</p>	<p><b>Biological</b></p> <p>The concern that fruit will become contaminated during transport through contact with pests, dirty transportation vehicles or through cross contamination from other fruit. Proper temperature control is important at this stage to minimize the growth of any existing pathogens. A number of outbreaks of Salmonella in cut melons have been attributed to improper storage temperatures following contamination (188, 189, 190, 196).</p>	<p>Nglg</p> <p>Now that fruit is individually packaged, the opportunity for external contamination or cross contamination is even lower. If contamination occurs it should be contained and localized.</p>	<p>Low-Med</p> <p>Since most minimally processed fruit is sold “ready to eat”, the risk of consumer exposure is higher because many products will be bought quickly and consumed as is, with no further processing or washing. If temperature abuse occurs at this stage there is potential for growth of the pathogen, thereby increasing the risk of exposure (196). Significant consumer exposure depends on the pathogen present and the individual.</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High  If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immunocompromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).	Low-Med  Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).	Nglg  Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.	Low-Med  There have not been any incidences directly associated with this processing step. However, a number of outbreaks associated with minimally processed fruit have been influenced by improper storage temperatures. This data provides reasonable certainty of assessment.	Nglg-Low  The risk of contamination is reduced at this stage but the risk of exposure is increased. The impact is variable and although specific data is limited the overall risk is expected to be mostly low.	To reduce risk: Keep transport vehicles clean. Know the other uses of the vehicle and understand the potential for foodborne pathogens on other products shipped in the same vehicle. Maintain temperatures below 4°C during transport and receiving when possible and minimize the amount of time the fruit is out of cold storage.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Shipping, Transportation and Distribution</b></p> <p>Transport of packaged fruit from the processing operation to a retail outlet.</p>	<p><b>Chemical</b></p> <p>The concern that fruit will become chemically contaminated through contact with climate control equipment, chemical sanitizers or from cross contamination during transport. While the level of chemicals in food is usually quite low. It has been suggested that foods are a potential source of exposure to chemicals (35, 36).</p>	<p>Nglg</p> <p>Chemicals are not normally used during transportation. Although localized contamination is possible, widespread contamination is not likely. Since fruit is in individual packages it is less likely to become contaminated.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, consumer exposure is unlikely but possible. Reduced time until consumption and the fact that the fruit is not likely to be washed again before consumption increase the likelihood of exposure. The risk of exposure is considered negligible to low. If contaminated fruit is consumed, exposure is likely to occur. The probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Low	Nglg	Low	Nglg	<p>To reduce risk: Monitor the use of all chemicals that could potentially contact the fruit during transport. Use only products registered for use and follow label recommendations. Clean and maintain climate control and other equipment that might contaminate the fruit.</p>
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Shipping, Transportation and Distribution</b></p> <p>Transport of packaged fruit from the processing operation to a retail outlet.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg</p> <p>The probability of any physical extraneous material contaminating the edible product is negligible. Fruit is unlikely to incorporate loose physical material into its structure. At this stage the product is usually in a container and therefore physical contamination is even less likely.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is very low. Any large extraneous material should be visible and subsequently removed prior to consumption.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Nglg-Low	Nglg	Low	Nglg	To reduce risk: Clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).
If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).	If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.	Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.	No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.	Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Retail</b></p> <p>Handling, display and sale of packaged minimally processed fruit products at retail outlets.</p>	<p><b>Biological</b></p> <p>The concern that fruit will become contaminated at the retail outlet. This may happen through contact with unsanitary equipment, pests, consumer handling, and cross contamination. Temperature is difficult to control at this stage and may lead to accelerated growth of any existing pathogens. A number of outbreaks of Salmonella in cut melons have been attributed to improper storage temperatures following contamination (188, 189, 190, 196).</p>	<p>Nglg</p> <p>Now that fruit is individually packaged, the opportunity for external contamination or cross contamination is even lower. If contamination occurs it should be contained and localized.</p>	<p>Low-Med</p> <p>Since most minimally processed fruit is sold “ready to eat”, the risk of consumer exposure is increased because many products will be bought quickly and consumed as is with no further processing or washing. If temperature abuse occurs at this stage there is potential for growth of the pathogen, thereby increasing the risk of exposure (196). Contamination occurring at this stage would likely be localized. Significant consumer exposure depends on the pathogens present and the individual.</p>	<p>Low*</p> <p>Some foodborne pathogens are easily transmitted directly by person to person, or by the fecal to oral route (9, 10, 21). After infection occurs, secondary spread among humans can occur (9, 22, 23). While primary exposure may be broadly distributed, secondary spread is expected to be local.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Low-High  If infection occurs the impact is variable depending on pathogen and the individual (9). The young, elderly and immunocompromised are at greater risk (21). Symptoms may include mild diarrhea and upset stomach. Some foodborne pathogens can be fatal (9, 11, 24, 25, 44).	Low-Med  Direct healthcare costs vary with pathogen virulence, individual susceptibility, and size of outbreak. If an outbreak is traced back to a specific company or industry, the indirect economic impact could be high (23, 26, 27, 28).	Nglg  Although no specific studies are known, the presence of biological hazards in crops is considered to have negligible impact on the environment.	Low-Med  There have not been any incidences directly associated with this processing step. However, a number of outbreaks associated with minimally processed fruit have been influenced by improper storage temperatures. This data provides reasonable certainty of assessment.	Nglg-Low  The risk of contamination is reduced at this stage but the risk of exposure is increased. The impact is variable and although specific data is limited the overall risk is expected to be mostly low.	To reduce risk: The same principals apply to storage at retail as storage during processing. The products should be packaged and displayed so as to minimize contact with consumers.+ Fruit should be stored and displayed at temperatures below 4°C.

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Retail</b></p> <p>Handling, display and sale of packaged minimally processed fruit products at retail outlets.</p>	<p><b>Chemical</b></p> <p>The concern that fruit will become chemically contaminated at retail through contact with climate control equipment, chemical sanitizers or cross contamination. While the level of chemicals in food is usually quite low. It has been suggested that foods are a potential source of exposure to chemicals (35, 36).</p>	<p>Nglg</p> <p>Chemicals are not normally used during retail sale. Although localized contamination is possible, widespread contamination is not likely. Since fruit is in individual packages it is less likely to become contaminated.</p>	<p>Nglg-Low</p> <p>Chemicals are not used during packaging. However, if fruit becomes contaminated at this stage, consumer exposure is unlikely but possible. Reduced time until consumption and the fact that the fruit is not likely to be washed again before consumption increase the likelihood of exposure. The risk of exposure is considered negligible to low. If contaminated fruit is consumed, exposure is likely to occur. The probability of significant human exposure varies with the chemical and the individual (39, 40).</p>	<p>Nglg</p> <p>Chemicals are not conducive to secondary spread among humans.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
on human health	economic	environment			
Nglg-Med	Low	Nglg	Low	Nglg	<p>To reduce risk: Monitor the use of all chemicals that could potentially contact the fruit during retail sale. Use only products registered for use and follow label recommendations. Clean and maintain climate control and other equipment that might contaminate the fruit.</p>
<p>The overall impact of chemicals on human health is generally quite low. Chemicals are rarely found on produce in high enough concentrations to cause acute health effects. Although the effects of long term exposure to many chemicals are not well known, there is evidence that exposure to certain chemicals over a long period of time can cause health effects including cancer (35, 36, 39, 40, 41, 42).</p>	<p>Direct healthcare costs vary with the scope of contamination and individual. If contamination is traced back to a specific company or industry the indirect economic impact could be higher (43).</p>	<p>At the levels that chemicals are found in fruit, the impact of contaminated fruit on the environment would be negligible.</p>	<p>No previous issues have been identified. Understanding of the industry and lack of trace back cases provides some certainty of assessment (35, 36, 40).</p>	<p>Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.</p>	

Activity	Hazard/ Concern	Risk Characterization		
		Probability (Likelihood of Going Wrong)		
		of contamination	of consumer exposure	of secondary spread among humans
<p><b>Post Processing</b></p> <p><b>Retail</b></p> <p>Handling, display and sale of packaged minimally processed fruit products at retail outlets.</p>	<p><b>Physical</b></p> <p>Concern that extraneous physical materials such as metal, wood, rocks, glass, plastic, etc., may contaminate the fruit. Physical hazards are known to cause injury (47, 48). See Appendix C for a list of physical material hazards.</p>	<p>Nglg</p> <p>The probability of any physical extraneous material contaminating the edible product is negligible. Fruit is unlikely to incorporate loose physical material into its structure. At this stage the product is usually in a container and therefore physical contamination is even less likely.</p>	<p>Nglg-Low</p> <p>If fruit becomes contaminated at this stage, the likelihood of consumer exposure is very low. Any large extraneous material should be visible and subsequently removed prior to consumption.</p>	<p>Nglg</p> <p>Physical hazards are not conducive to secondary spread.</p>

Risk Characterization			Risk Summary		Recommendations for Action
Impact (Consequences of Going Wrong)			Uncertainty of Data	Summary of Risk and Uncertainty	
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Nglg-Med  If contamination occurs The impact is variable depending on the physical hazard and the individual. Physical hazards are known to cause injury (47, 48).	Nglg-Low  If contamination and or exposure occurs and is traced back to an individual company or industry, the economic impact would be variable depending on the type and extent of physical contamination as well as the product.	Nglg  Although no specific studies are known, the impact of physical hazards in any food crop on the environment is considered negligible.	Low  No previous issues have been identified with minimally processed fruit. Experience and knowledge of fruit processing practices provide reasonable certainty of assessment.	Nglg  Although the impact is variable and there is some uncertainty, the likelihood of contamination and exposure are considered mostly negligible. Therefore it is reasonably certain that the overall risk at this stage is negligible.	To reduce risk: Clean and maintain equipment in good repair. Be aware of and provide information to employees on potential physical material hazards (30, 31).