
**QUALITY CONTROL / QUALITY ASSURANCE AND INTERNATIONAL TRADE;
GOOD MANUFACTURING PRACTICES (GMP); HYGIENE REQUIREMENTS;
HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP)**

**for
FRUITS AND VEGETABLES PROCESSING
in
DEVELOPING COUNTRIES**

I. QUALITY CONTROL / QUALITY ASSURANCE AND INTERNATIONAL TRADE

1.1. General considerations

The international trade in processed fruits and vegetables is very large with an ever increasing number of different types being processed and exported. Whereas once, processing was limited to mostly temperate climate fruits and vegetables, the change has now broadened to include tropical and subtropical types. The reasons are twofold. Firstly, consumers' dietary habits have become more diverse so that, for example people living in North America may very well like fruits and vegetables grown in Africa or Asia. Secondly, processing techniques, whether they be for canning, freezing or drying, have been improved to an extent where final product is palatable, nutritious and of long and reliable shelf life. Many developing countries have taken advantage of the continuing worldwide demand for processed fruits and vegetables and earned valuable foreign exchange from exports of products to profitable markets.

The export quality control and inspection of processed fruits and vegetables is directed at ensuring that the final products:

- have been processed in a registered export establishment that is constructed, equipped and operated in an hygienic and efficient manner;
- conforms to the requirements of the export regulations for processed fruits and vegetables, and those of the importing country, in respect of such things as quality grades, defects, ingredients, packaging materials, styles, additives, contaminants, fill of container, drained weight; and,
- conforms to labeling requirements.

1.2. Inspection and certification procedures

In most countries, in processing fruits and vegetables for export, it is not customary to apply continuous inspection as it is in the case of meat. Few, if any, importing countries require it, and the nature of the products themselves is such that only part time check inspection is required during processing together with statistically based inspection, including sampling and analysis, of final product. However, in circumstances where an establishment is processing export product for the first time, it can be argued that there is merit in adopting continuous inspection until the operation is satisfactorily established.

In any event, inspection of raw materials should be carried out at the commencement of each processing run to ensure that only sound fruit or vegetables of sufficient maturity (degree of ripeness) is used for processing. Check inspections of raw materials should be carried out as frequently as the inspector thinks necessary.

The inspector must ensure that adequate hygiene practices are followed during the processing of the product. For example, in the case of canned and frozen products and other processing methods, raw materials should be washed absolutely clean so that fruit and vegetables entering the processing lines

are free from filth, superficial residues of agricultural chemicals, insects and extraneous plant material. In the case of dried product, especially where the raw material is sun dried on drying greens or racks, care must be taken to minimize contamination by bird and animal droppings, dust and extraneous plant material. Washing of dried product is often necessary to ensure cleanliness of the final product. In the case of canning and freezing, the inspector must obtain from management full details of the processing programme for at least the following day, so that an adequate inspection programmes can be scheduled.

In much the same way as for fresh fruits and vegetables, the inspector must also be aware of the pesticides and other chemicals used in the production of the raw materials. Necessary laboratory analyses can then be arranged to ensure residue levels in the final product do not exceed tolerances adopted by importing countries. At the commencement of and during processing, the inspector should pay attention to the state of raw materials, the preparation of raw materials for processing (peeling, slicing, dicing, blanching, etc.), preparation and density of packing medium (sugar syrup, salt brine, etc.), the state of cans or containers to be used (cleanliness and strength), the cooking or freezing process (time/temperature relationship), can filling and closure and can/container storage.

After processing, the inspector should check the final product to ensure the drained or thawed weight, the vacuum and headspace, packing medium strength and that can / container conditions are satisfactory. Statistically based sampling plans should be adopted for the examination of final product to ensure it meets the requirements of the export regulations. The labeling applied to cans / containers should also be checked to ensure both their correctness and compliance with the export regulations and the requirements of those countries in which the product is to be marketed. Cans should also be examined to make sure that the correct embossing relating to the product, its date of production and the registered number of the export establishment has been applied. Each registered export processed fruits and vegetables establishment for canned or frozen foods should have its own quality laboratory sufficiently equipped and staffed to carry out physical, chemical and microbiological examinations of the goods.

Inspectors should have access to the laboratory facilities and the establishment's quality control records as and when required. Independent laboratory examination of product should be made by the agency having responsibility for export on the basis of a statistically developed sampling plan.

In those countries where fruit and vegetable production is a seasonal event, processing for export generally takes place at the time of peak production and then declines, often to a halt, as the supply of raw materials declines. As a result, most export establishments produce at their peak of production far more product than they export at that time. Therefore, most of manufacturers find it necessary to store product for considerable periods before it is exported. Thus, proper storage is essential if product is to retain its quality and cans remain untarnished. Inspectors should regularly inspect storage facilities, noting their conditions and that of the stored product, looking for signs of deterioration such as pest infestation and rusting of cans.

Prior to export, the exporter should be required to notify the export quality and inspection agency of his intention to export in accordance with the provisions of the export processed fruits and vegetables regulations and on the prescribed "Notice of Intention to Export" form. The notice should be submitted in sufficient time before the shipment date to enable the product to be inspected satisfactorily; the intensity of inspection depending on the original state of the product, the conditions under which it has been stored and the length of storage. When product is approved, the agency will issue the exporter an "Export Permit" authorizing Custom's clearance of the product.

1.3. Labeling

Customers and consumers expect the labeling on food to be a true description of what they are buying. Misleading or fraudulent labeling is an unfair trade practice that cannot be tolerated.

Most countries now have labeling laws stipulating how foods are to be labeled and what information labels must contain. Most, if not all of those laws have in common requirement that the label should bear:

- a statement of identity and a true, as distinct from misleading, description of the product;
- a declaration of net contents (weight or number of pieces);
- the name and address of the manufacturer, packer, distributor or consignee, and
- a list of ingredients (in descending order of volume or weight).

In addition, labels may also be required to include, amongst other things, the country of origin, date of manufacture or packing, a use-by or expiry date, nutritional qualities or values of the food, storage directions, a quality grade and directions for preparing the food.

More frequently than is often realized, consignments of food exports arriving on foreign markets are not permitted entry because the labeling does not comply with the mandatory requirements of the importing country. This sometimes results in consignments being rejected, but more often in them being withheld from entry until the labeling is corrected or new labeling applied. In either case, trade is interrupted and the cost involved may make sales unprofitable. It is essential therefore, that exporters be familiar with the food labeling requirements of importing countries.

1.4. Export Quality Control and Inspection Systems for Foods

With the advent and development of a food consciousness amongst consumers, stimulated by the work of the Joint FAO/WHO Codex Alimentarius Commission through its elaboration of food standards, codes of hygienic practice and the Code of Ethics for International Trade in Food, an increasing number of countries have adopted sophisticated food laws and established food control agencies. Consequently, those countries no longer accept products on trust that they are satisfactory, but instead, demand that food imports meet the requirements of their food laws and pass inspection by their control agencies. Moreover, many of them require exporting countries to certify that products comply with their national legislation and some also require additional special declarations.

As a result of these developments the emphasis of activity of Export Quality Control and Inspection Systems has changed. Although most of them still establish their own standards of quality control and adopt standards for foods for export, most of their effort and resources are now directed at ensuring that foods for export meet the mandatory requirements of importing countries and providing the necessary associated certification. To do otherwise is to invite either the detention or, at worst, rejection of product at point of entry.

1.5. Detentions and rejections

No longer can food exporting countries assume that there is a good chance that products not complying with the requirements of importing countries will escape the inspection at the point of entry. Details of foods imports released by the United States Food and Drug Administration (FDA) indicate that significant quantities of product are at least detained, and at worst rejected, because they fail to meet U.S. food laws. Reasons given for the detentions include:

- non compliance with labeling requirements;
- decomposition;
- insect and animal filth and damage;
- use of prohibited additives;
- non compliance with requirements of the U.S. low acid canned food regulations;
- heavy metal contamination;
- excessive levels of pesticide residues;
- excessive levels of mycotoxin;
- mold infestation;
- microbiological contamination;
- swollen and otherwise faulty cans.

The message for food exporting countries is quite clear - ensure your products comply with the mandatory requirements of importing countries or run the very real risk of having them rejected at considerable financial loss to the exporter and the country and resulting in damage to the commercial reputation of both. While the foregoing relates to the U.S.A. experience, because it is the only country that currently publishes data about detentions and rejections of food imports it can be assumed that record more or less reflects the experience of other food importing countries. It might well be asked why such significantly high levels of detentions and rejections of food imports take place.

Undoubtedly the reasons are many and varied. However, the evidence shows that the most important reasons include:

- the inability of some export food industries, especially in developing countries, to handle, process, package and transport products to meet the mandatory requirements of importing countries;
- lack of awareness by food exporting countries of the mandatory requirements of importing countries, including certification;

- lack of adequate export control programmes and related agencies in food exporting countries, preventing them from exercising the necessary product surveillance and giving reliable and credible certification, and
- a lack of communication, between food control authorities and agencies in exporting and importing countries.

All four reasons can be remedied by governments if they possess sufficient political will and take the necessary steps to do so.

II. GOOD MANUFACTURING PRACTICES (G.M.P.); HYGIENE REQUIREMENTS

2.1. Personnel

2.1.1. Disease control. - Any person who has an illness, open lesions, including boils, sores, infected wounds, or any other abnormal source of microbial contamination must not work in any operation (in a food processing center) which could result in the food, food-contact surface, or food packaging materials becoming contaminated.

2.1.2. Cleanliness. - The following applies to people who work in direct contact with food preparation, food ingredients or surfaces of equipment or utensils that will contact food:

- they must wear clean outer garments, maintain a high degree of personal cleanliness and conform to hygienic practices while on duty;
- they must wash their hands thoroughly and, if they are working at a job where it is necessary, they must also sanitize their hands before starting work, after each absence from the workstation and at any other time when the hands have become soiled or contaminated;
- they must also remove all unsecured jewelry. People who are actually manipulating foods by hand, should remove any jewelry from their hand that cannot be properly sanitized;
- it is necessary to wear effective hair restraints, such as hairnets, caps, headbands or beard covers;
- operators must not store clothing or other personal belongings in food processing areas. Also, eating food, drinking beverage or using tobacco (in any form) must not be allowed in food processing area;
- all necessary steps have to be taken by supervisors to prevent operators from contaminating foods with microorganisms or foreign substances such as perspiration, hair, cosmetics, tobacco, chemicals and drugs.

2.1.3. Education and training. - Persons who are monitoring the sanitation programs must have the education and/or experience to demonstrate that they are qualified. Food handlers and supervisors should receive training that will make them aware of the danger of poor personal hygiene and unsanitary work habits.

2.1.4. Supervision. - Someone must be assigned the responsibility that all personnel will comply with all the requirements of these G.M.P.'s.

2.2. Plants and grounds

2.2.1. Grounds around a food processing center which are under the control of this center must be free from conditions such as: improperly stored equipment; litter, waste or refuse; uncut weeds or grass close to buildings; excessively dusty roads, yards or parking lots; inadequately drained areas - potential foot-borne filth or breeding places for insects or microorganisms; inadequately operated systems for waste treatment and disposal.

2.2.2. Plant construction and design shall:

- provide enough space for sanitary arrangement of equipment and storage of materials;
- floors, walls and ceilings must be constructed so that they are cleanable and must be kept clean and in good repair;
- separate by partition, location, time and other means, any operations that may cause cross-contamination of food products with undesirable microorganisms, chemicals, filth or other extraneous material;
- provide effective screening or other protection to keep out birds, animals and vermin such as insects and rodents.
- provide adequate ventilation to prevent contamination of foods with odors, noxious fumes or vapors (including steam);
- light bulbs, skylights or any other glass must be of the safety type or protected so that glass contamination cannot occur in case of breakage.

2.3. Sanitary operations

2.3.1. General maintenance. - The plant and all fixtures must be kept in good repair and be maintained in a sanitary condition. Cleaning operations must be conducted in a manner that will minimize the possibility of contaminating foods or equipment surfaces that contact food.

2.3.2. Pest control

- a) No animals or birds are allowed anywhere in the plant
- b) Programs must be in effect to prevent contamination by animals, birds and pests, such as rodents and insects;
- c) Insecticides and rodenticide may be used as long as they are used properly (according to label instructions);
- d) These pesticides must not contaminate food or packaging materials with illegal residues;

2.3.3. Sanitation of equipment and utensils

- a) Utensils and equipment surfaces that contact food must be cleaned as often as necessary to prevent food contamination;
- b) Equipment surfaces that do not contact foods should be cleaned as frequently as necessary to minimize accumulation of dust, dirt, food particles, etc...
- c) Single-service articles such as disposable utensils, paper cups, paper towels, etc., should be:
 - Stored in appropriate containers;
 - Handled, dispensed, used and disposed of in a manner that prevents contamination of food or equipment;
- d) Where there is the possibility of introducing undesirable microorganisms into food, all utensils and equipment surfaces that contact food must be cleaned and sanitized before use and following any interruption during which they may have become contaminated;
- e) When utensils or equipment are used in a continuous production operation, they must be cleaned and sanitized on a predetermined schedule;
- f) Any facility, procedure, machine or device may be used for the cleaning and sanitizing, as long as it has been established that the procedure will do the job effectively.

2.3.4. Storage and handling of clean portable equipment and utensils

- a) This refers to portable equipment or utensils which have surfaces that will contact foods;
- b) When such equipment or utensils have been cleaned and sanitized, they should be stored in a manner that will protect the food contact surfaces from splash, dust and other contamination.

2.4 Sanitary facilities and control

2.4.1. Water supply. - Any water that contacts food or processing equipment must be safe and of adequate sanitary quality.

2.4.2. Sewage disposal - Must be made into an adequate sewage system or disposed of through other adequate means.

2.4.3. Plumbing - Must be of adequate size and design to:

- a) Supply enough water to areas in the plant where it is needed;
- b) Properly convey sewage or liquid disposable waste from the plant;
- c) Not create a source of contamination or unsanitary condition;
- d) Provide adequate floor drainage where hosing-type cleaning is done or where operations discharge water or liquid waste onto the floor;
- e) Insure that there is no backflow from cross-connection between piping systems that discharge waste water or sewage, and those that carry water for food or food manufacturing.

2.4.4. Toilet facilities

- a) Toilets and hand-washing facilities must be provided inside the fruit and vegetable processing centers;
- b) Toilet tissue must be provided;
- c) Toilets must be kept sanitary and in good repair;
- d) Toilets rooms must have self-closing doors;
- e) Toilets rooms must not open directly into areas where food is exposed unless steps have been taken to prevent airborne contamination (example: double doors, positive airflow, etc.);
- f) Signs must be posted that direct employees to wash their hands with soap or detergent after using the toilet.

2.4.5. Hand-washing facilities

- a) Adequate and convenient hand-washing and, if necessary, hand-sanitizing facilities must be provided anywhere in the plant where the nature of employees jobs requires that they wash, sanitize and dry their hands;
- b) These hand-washing facilities must provide:
 - Running water at suitable temperature;
 - Effective hand-cleaning and hand-sanitizing preparations;
 - Clean towel service or suitable drying devices;
 - Easily cleanable waste receptacle;
 - Water control valves designed and constructed to protect against recontamination of clean, sanitized hands;
 - Signs directing employees handling unprotected food to wash and, if appropriate, sanitize their hands before starting work, after each absence from the workstation, and any other time when the hands have become soiled or contaminated.

- 2.4.6. Rubbish and offal disposal must be handled in such a manner that they do not serve to attract or harbor pests or create contaminating conditions.

2.5 Equipment and utensiles

- a) Equipment and utensils must be designed and constructed so that they are adequately cleanable and will not adulterate food with lubricants, fuel, metal fragments, contaminated water, etc.
- b) Equipment should be installed so that it, and the area around it, can be cleaned;
- c) Food contact surfaces shall be made of nontoxic materials and must be corrosion-resistant;
- d) Seams on food contact surfaces shall be smoothly bonded, or maintained in order to minimize the accumulation of food particles, dirt and organic matter;
- e) Equipment in processing areas that does not come into contact with food shall be constructed so that it can be kept clean;

- f) Holding, conveying and manufacturing systems, including gravimetric, pneumatic, closed and automated systems, shall be maintained in a sanitary condition;
- g) Each freezer and cold storage compartment shall have an indicating thermometer, temperature measuring or recording device, and should have an automatic control for regulating temperature, or an automatic alarm system to indicate a significant temperature change;
- h) Instruments and controls used for measuring, regulating or recording temperatures, pH, acidity, water activity, etc. shall be adequate in number, accurate and maintained.

2.6 Processes and controls

There must be an individual who is responsible for supervising the overall sanitation of the plant.

2.6.1 Raw materials and ingredients

- a) Must be inspected and segregated to assure that they are clean, wholesome and fit for processing into human food;
- b) Must be stored under conditions that will protect against contamination and minimize deterioration;
- c) Must be washed or cleaned to remove soil and other contamination:
 - Water used for washing, rinsing or conveying food products must be of sanitary quality;
 - Water must not be reused for washing, rinsing or conveying if contamination of food may result;
 - Containers and carriers (such as trucks or railcars) should be inspected to assure that their condition has not contaminated raw ingredients;
- d) Raw materials shall not contain levels of microorganisms that may produce food poisoning or other disease, or they shall be pasteurized or otherwise treated during manufacturing operations so that the product will not be adulterated;
- e) Materials susceptible to contamination with natural toxins, e.g., aflatoxin, shall comply with national and international official levels before they are incorporated into the finished food;
- f) Materials susceptible to contamination with pests, undesirable microorganisms, or extraneous material, shall comply with national and international regulations, guidelines and defect action levels;
- g) Materials shall be stored in containers, and under conditions which protect against contamination;

h) Frozen materials shall be kept frozen. If thawing is required prior to use, it shall be done in a manner that prevents contamination.

2.6.2. Manufacturing operations

a) Food processing equipment must be kept in a sanitary condition through frequent cleaning and, when necessary, sanitizing. If necessary, such equipment must be taken apart for thorough cleaning.

b) IT IS NECESSARY TO PROCESS, PACKAGE AND STORE FOOD under conditions that will minimize the potential for undesirable microbiological growth, toxin formation, deterioration or contamination. To accomplish this may require careful monitoring of such factors as time, temperature, humidity, pressure, flow rate, etc. The objective is to assure that mechanical breakdowns, time delays, temperature fluctuations or other factors do not allow the foods to decompose or become contaminated.

c) Food shall be held under conditions that prevent the growth of undesirable microorganisms as follows:

- Refrigerated foods shall be maintained at 45°F or below;
- Frozen foods shall be maintained in a frozen state;
- Acid or acidified foods to be held in hermetically sealed containers at ambient temperatures shall be heat-treated to destroy mesophilic microorganisms;

d) Measures such as sterilizing, irradiating, pasteurizing, etc., shall be adequate to destroy or prevent the growth of undesirable microorganisms;

e) Work-in-process shall be protected against contamination;

f) Finished food shall be protected from contamination;

g) Equipment, containers and utensils shall be constructed, handled and maintained to protect against contamination;

h) Measures, e.g., sieves, traps, metal detectors, shall be used to protect against the inclusion of metal or other extraneous material in food;

i) Food or materials that are adulterated shall be disposed of in a manner that prevents other food from being contaminated;

j) Mechanical manufacturing steps such as washing, peeling, etc., shall be performed to protect against contamination by providing adequate protection from contaminants that may drip or be drawn into the food, by adequately cleaning and sanitizing all food-contact surfaces and by using time and temperature controls at and between each manufacturing step;

k) Heat-blanching should be done by heating the food to the required temperature, holding it at this temperature for the required time, and then either rapidly cooling the food or passing it to the next manufacturing step without delay;

l) Filling, assembling, packaging, and other operations shall be performed in such a way that the food is protected against contamination by:

- Use of a quality control operation in which the Critical Control Points are identified and controlled during manufacturing;
- Adequate cleaning and sanitizing of all food-contact surfaces and food containers;
- Using materials for food containers and food-packaging materials that are safe and suitable;
- Providing physical protection from contamination, particularly airborne contamination;
- Using sanitary handling procedures.

m) Food such as, but not limited to, dry mixes, nuts, intermediate moisture food, and dehydrated food, that relies on the control of aw for preventing the growth of undesirable microorganisms shall be processed to and maintained at a safe moisture level by:

- Monitoring the Aw of food;
- Controlling the soluble solids / water ratio in finished food;
- Protecting finished food from moisture pickup, by use of a moisture barrier, or by other means, so that the Aw of the food does not increase to an unsafe level;

n) Food such as, but not limited to, acid and acidified food, that relies principally on the control of pH for preventing the growth of undesirable microorganisms shall be monitored and maintained at a pH of 4.6 or below by:

- Monitoring the pH of raw materials, food in process, and finished food;
- Controlling the amount of acid or acidified food added to low-acid food;

o) If ice is used and comes in contact with food products, it must be made from potable water and be in a sanitary condition;

p) Areas and equipment that are used to process human food should not be used to process nonhuman food-grade animal feed, or inedible products unless there is no possibility of contaminating the human food;

q) A CODING SYSTEM should be utilized that will allow positive lot identification in the event it is necessary to identify and segregate lots of food that may be contaminated. Records should be kept for a period of time that exceeds the self life of the product, except that records need not be kept beyond two years.

2.6.3 Warehousing and distribution

FINISHED FOOD PRODUCTS should be stored and transported under conditions that will prevent contamination and protect against deterioration of the products or their containers.

III. HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCP)

3.1 Preprocessing steps - converting raw foods to ingredients

Fruits and vegetables as raw materials start as living cells and as such can vary in composition, color, flavor structure and nutrient content. Thus a key part of describing a process is the preparation of detailed specifications for ingredients and packaging materials to ensure that final product performance and composition specifications can be met with the specified process and equipment. This is only possible if ingredients are reprocessed to the desired specifications.

Thus the processing of foods must be separated into two broad areas:

- preparation of raw fruits and vegetables for further processing;
- assembly of reprocessed ingredients to consumer products.

The assembly of reprocessed ingredients to consumer products will be discussed to illustrate principles used to describe a process for quality control. These principles apply to the conversion of raw foods to processed products. The chief differences are the variations in raw product specifications and certain washing, peeling, size reduction and blanching or heat treatment steps need to convert highly variable raw materials to standardized ingredients.

Typical operations using in converting raw fruits and vegetables to processed ingredients for packaging and preservation or prior to a further heat treatment processing are as follows:
Harvesting or Gathering --> Transport --> Storage --> Washing--> Size Grading --> Peeling (Removal of outer surface) --> Size Reduction --> Separation of waste --> Sorting Inspection --> Storage.

3.2 Process description for Quality Control

One of the most important specifications of a product is its safety in terms of microbial contamination, freedom from hazardous chemicals and absence of foreign materials such as metal pieces, non-edible parts such as pits or woody stem material and dirt, insect parts or other extraneous material. The microbial safety of processed fruits and vegetables is of prime importance from a quality viewpoint. The following analysis is to provide a description of a process to help ensure that microbial safety can be achieved with a minimum opportunity for failure of the finished product to meet specifications.

3.3 Process operations

Food processing steps require a detailed description when microbial safety is a concern. The reason for this is that ingredients, packages, equipment, and the surroundings all potentially can contaminate the final product with pathogenic or spoilage microorganisms. Table 10.3.1 is a simple process description from a Hazard Analysis point of view.

Further, if the conditions of pH (acidity), temperature, moisture and nutrient level are proper, rapid microbial growth is possible on process equipment and in the food itself. Thus while microbiological specifications can be written for incoming ingredients, actual microbial counts can increase during each process step if the process is not designed properly.

One of the first requirements for the description of a process is to determine if an individual process step will increase (+), decrease (-) or result in no change (=) in the microbial content of food undergoing the processing step. This can be determined from the chemical and physical conditions of the food and surroundings in each processing step. The physical and chemical conditions of a food passing through a processing step can be recorded for each process step needed to prepare a finished product.

Fig. 3.1 is an example of a process for preparing a canned juice drink using a hot fill to prevent subsequent spoilage. A hot fill can be used since the product has pH below 4.5 and thus is considered an acid product. The product contains four ingredients: fruit concentrate, flavor mix, sugar and water. Two package components are shown: the can and the can cover.

Individual processing steps are identified in the preparation of the canned juice drink from warehouse inventory to just prior to can labeling. Processing steps needed to prepare the package for filling and sealing are listed on the right side of the chart.

For purpose of analyses the juice drink must have a pH of 3.8, a fill temperature of no lower than 190EF and must leave the cooling tunnel at a temperature below 90EF. These requirements are highlighted in their appropriate column to ensure that the proper process control and quality control procedures are in place.

Fig. 3.1 has a column titled: "Potential for microbial growth if out of control". This column is included to allow each step to be challenged from a microbiological viewpoint. "What ifs" will show whether the specified Critical Control Points will protect the product from microbial failure.

Two sources of failure are evident. The can fill temperature must be 190EF or above and regular can and lid inspections are needed to ensure that double-seals are always within specifications. The pH of the system may be less critical since the fruit concentrate will bring the pH below 4.5 even without the dry mix.

The process steps shown in Figure 3.1 can be contrasted with the process used in the preparation of a vacuum packed, refrigerated, cooked meat soup (shown in Figure 3.2). This product depends on low temperatures for preservation as well as low vegetative microbial counts; equipment sanitation, prevention of air borne contamination during filling, seal integrity and rapid cooling are essential parts of the process.

Even with these requirements in control, the heat treatment given the products (heating to 200EF), with a variable 0-60 min hold) is not sufficient to inactivate *Clostridium botulinum*. Thus the product must be cooled to 35EF within 40 minutes to prevent any possible germination and outgrowth of *Clostridium botulinum* spores.

Further, the manufacturer of this product must provide a means to ensure that the product is used within a specified time and is always kept at or below 35EF if it is to be released to the public.

3.4 Food processes in general

The above commented figures show typical product preparation sequences for a thermally preserved and a refrigerated products. It is important to know the following information to determine the microbial safety of a product and to determine what quality control actions will be needed to achieve a safe product when used under the conditions for which it was designed.

First, all raw material, ingredients and packaging materials in contact with the food must be specified and if needed tested to meet specifications. Second, it is important that a "ride" be taken on an element of food as it enters, passes through and leaves the process. This ride on a particle of the food should provide the following data at each process step from entry to discharge:

- Food temperature;
- Time at each temperature;
- pH;
- Oxygen concentration;
- Water activity.

Further, if preservatives are required to prevent microbial growth, their addition point and concentration throughout the entire food mass should be shown. Finally for products which depend on a sealed package one should check the seal integrity of each container produced. As one rides along the food as it travels through each step it is necessary also to observe the number and types of microorganisms entering or leaving the food and if these numbers are increasing (+), decreasing (-) or remaining the same (=).

These data when reviewed for quality control procedures will help ensure a safe, reliable and cost effective process.

Figure 3.1 Canned juice drink - providing a basis for Hazard Analysis (HACCP) *

OPERATION	EQUIPMENT	(+, -, =)	REASON **	TEMP. (EF)
1 Storage	Warehouse			
2 Transport	Fork lift			
3 Storage	Storage tank			
4 Weigh dry ingredients	Scale	+	Poor sanitation	
5 Weigh wet ingredients	Weigh kettle	+	Poor sanitation	
6 Blend***	Kettle			
7 Heat	Kettle	=	Low temperature	195
8 Transport	Pump	=	Sanitation	190
9 Delay	Surge tank	=	Low temperature	190
10 Filler bowl level control	Valve	=	Sanitation	190
11 Separation	Pipe filter	=	Sanitation	190
12 Can fill	Filler	=	Low temperature	190
13 Lid coding	Coder			
14 Seam	Double seamer	+	(Poor Seams)	190
15 Lid sterilization	Can inverter	=		190
16 Hold delay	Conveyor	=		190
17 Can cooling	Cooling tunnel	=		90
18 Drying	Can drier	+	Insufficient heat, leaks	

* Source: D.F. Farkas (1991)

** "Potential for microbial growth if out of control"

*** pH of the product is 3.8

Figure 3.2 Vacuum packed refrigerated meat soup - providing a basis for Hazard Analysis*

OPERATION	EQUIPMENT	(+ , - ,=)	REASON**	TEMP. (EF)
Storage	Warehouse			
Transport	Forklift			
Weigh water	Weigh kettle			
Blend***	Kettle	+	Poor sanitation	
Heat****	Kettle	+	Slow heating	200
Transport	Pump	+	Poor sanitation	195
Filter	Screen	+	Sanitation	195
Control	Float in bowl	+	Sanitation	190
Fill	Filler	+	Sanitation, air contamination	190
Lid	Sealer	+	Contaminated, poor packaging, seal	190
Tub	Cooling	+	Slow, poor cooling*****	35

* Source: D.F. Farkas (1991)

** "Potential for microbial growth if out of control"

*** pH of the product is 6.3

**** 30 min total time (60 min as kettle is used as filler supply tank for 30 min)

***** Product must be held at 35EF until used

SIMPLE PROCESS DESCRIPTION FOR HAZARD ANALYSIS
ONION PROCESSING UNIT - TECHNOLOGICAL LINE FOR DEHYDRATION
BELT DRIERS

EQUIPMENT	OPERATION
(1) Device for emptying of raw material transport boxes	Unloading
(2) Vertical elevator	Transport
(3) Peeling machine	Peeling / "cleaning" of raw material by dry method
(4) Sorting and control belt	Control
(5) Size grader	Grading
(6) Distribution table	
(7) Bagging machine	
(8) Vertical transporter	Transport
(9) Machine for cutting of ends	Cutting
(10) Transporter with weighing device	Transport & weight measure
(11) Cleaning machine	Cleaning
(12) Vertical transporter	Transport
(13) Cutting machine	Cutting
(14) Transport belt with water sprays	Transport & washing
(15) Vertical transporter	Transport
(16) & (17) Device for adjusting drying belt speed	Belt speed regulation
(18) Belt type drier	Drying