Quality Assurance for Processed Fruit & Vegetable Products

by Diane M. Barrett

Processed fruit and vegetable product quality is determined by the quality of the raw materials utilized (e.g. cultivar, maturity, cultural practices) and the efficiency and care taken during handling, processing, storage and distribution. As with fresh horticultural commodities, it is important to establish quality standards and to ensure their fulfillment through the use of a quality assurance program at the processing facility. This article will address establishment of quality standards, sampling techniques and evaluation of a select number of specific attributes.

Establishment of Quality Standards

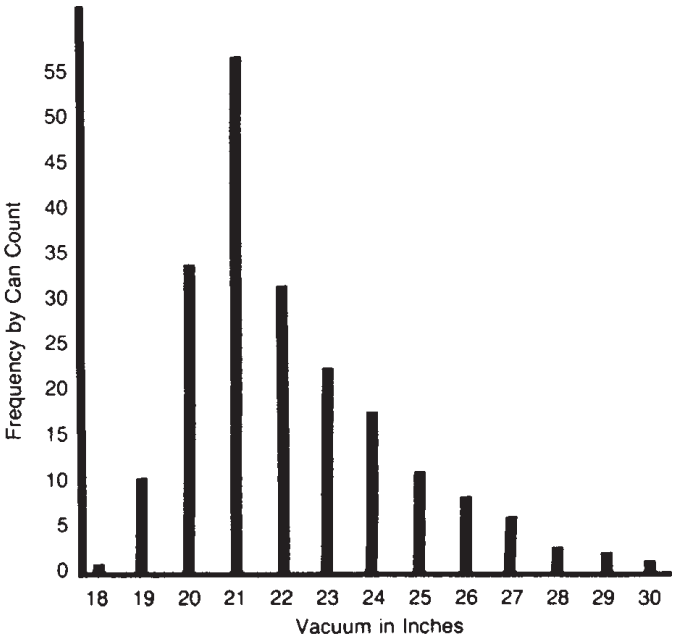
Quality standards originate in a number of different ways. In order to prevent adulteration of processed products, mandatory standards have been established by federal, state and municipal agencies to ensure freedom from insects, molds, yeasts and pesticides. In such standards, maximum levels of additives are often specified and specific processing conditions may be stipulated. Many processed products are graded in terms of their "freedom from defects", which may include peel or core material, blemished areas, discolored areas, harmless extraneous materials etc.

The food industry or individual companies also establish standards by which to distinguish their processed products. These standards are voluntary but are usually put into place in order to improve product quality and are often more stringent than required by law. Pressure from marketing organizations or specific commodity groups may initiate such standards, and some examples include cling peaches, peanut butter and some frozen foods.

Sampling Techniques

Samples must be representative of the lot in question, and randomly taken. Often the downfall of an otherwise successful quality assurance program is its sampling plan (or lack thereof!). The U.S. Department of Agriculture utilizes a statistical sample plan and regulations governing inspection and certification of processed fruits and vegetables. This plan specifies sampling procedures based on total lot size, outlines statistical quality control (SQC) procedures and acceptance levels. Many companies utilize SQC procedures because they provide a straightforward means to sample product, determine the quality variation and relate results to the whole lot under consideration. SQC histograms and charts allow for quick and easy tracking of quality trends during production. Figure 1 is an example of an SQC histogram for inches of vacuum in canned soup.

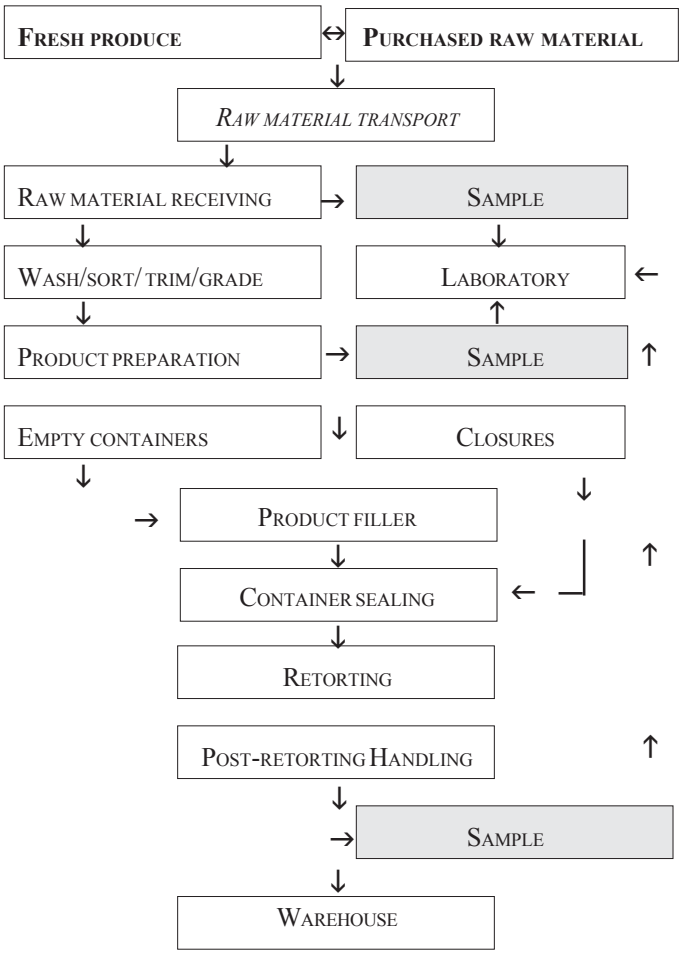
Figure 1. (Gould, 1983)



~~FIG. 2.1~~. HISTOGRAM FOR VACUUMS IN CANNED SOUP

Samples should be taken from a number of points in the processed product chain to ensure product safety and quality. It is crucial for companies to outline the flow of their products in a specific chart which will assist them in determining inspection points. Figure 2 shows an example of a general flow chart for canned horticultural commodities. This chart indicates that samples or some time of record might be made at fifteen different points in the chain, from the fresh produce acquisition to the warehouse.

Figure 2. *(FAO, 1981)*



Container Evaluation

One thing which distinguishes processed from fresh fruit and vegetable product evaluation is the need to evaluate the container. Containers for canned, frozen, dried, pickled or otherwise processed products should be evaluated both prior to and after filling and processing. Key factors in container quality include size, net weight, seal integrity, vacuum, headspace, drained weight and internal/external condition. Processed product quality and safety are significantly influenced by the quality of the container. For example, a leak or break in the seam of a can of low acid vegetables such as green beans or carrots may allow for introduction of dust, moisture or filth which may contain microorganisms capable of creating a food safety hazard.

Processed Product Quality Evaluation

Processed fruit and vegetable quality evaluation often includes determination of the following attributes:

- brine or syrup concentration and specific gravity
- titratable acidity or pH
- flavor, odor and color, by subjective or instrumental means
- size, shape and symmetry
- maturity/character or soluble/total solids
- texture, viscosity or consistency
- defects such as soft, overripe or underripe, discolored, insect damaged or moldy fruit
- enzymes responsible for flavor, odor, color or textural changes

Evaluation of color, size and shape, defects, maturity, firmness, soluble solids and titratable acidity in fresh horticultural commodities have been discussed in a previous article in this volume, and methods for processed products are similar. Therefore the following discussion will concentrate on evaluation of brine, syrup and specific gravity; flavor and odor and enzymes.

Brines, Syrups and Specific Gravity

Salt brines and sugar solutions or syrups are often added to processed products to both improve flavor and quality and to assist in processing and control of preservation. Brines are normally made with water, salt and/or sugar. All brines should be added to the product as close to the boiling point as possible. Oftentimes brines become cloudy or viscous following processing or particularly immature or over-mature vegetables due to dissolution of suspended material (pectin or starch). For this reason, it is important to select appropriate cultivars of the optimal maturity, to segregate like qualities of raw material and to use water free of soft minerals and organic matter for brine makeup. Clearness of brine is often evaluated in a subjective manner. The brine is poured into a cylinder and its clarity is observed by placing the cylinder against a background with standard lines and the sharpness of these lines is noted.

Sugar is essential to the manufacture and preservation of jams, jellies, marmalades, apple butter, pickles, candy, most canned fruits, many fruit drinks and beverages, several vegetables and many specialty products. Sugar serves a number of roles, including improvement of flavor, color, texture and appearance; exclusion of air; provision of energy or nutritive value and control of microbial growth in concentrated products (e.g. jams, jellies and preserves). Initial sugar levels in raw fruit or vegetable should be analyzed prior to addition of sugar by blending the sample, straining it through cheesecloth and measuring sugar content by a

hydrometer or refractometer. Federal minimum sugar content standards for jellies, preserves and jams require not less than 65% soluble solids in jams and jellies and not less than 43% in fruit butter.

Many vegetables (peas, corn, potatoes) undergo an increase in density or specific gravity as they mature and this difference can be utilized as a means of product differentiation or sorting prior to processing. In addition, specific gravity or concentration of food products such as tomato paste, orange juice concentrate and baby foods is important for both manufacture and labeling.

Flavor and Odor

Flavor and odor of processed foods are among the most important quality attributes and while instrumental methods of evaluating them exist, subjective or human evaluation techniques are often more appropriate and more sensitive. There are basically two types of subjective evaluation which may be carried out: consumer acceptance (preference) and panel difference methods. Consumer acceptance tests are utilized to evaluate new products, changes in manufacturing procedures, reformulations or line extensions of existing products, or for routine quality checking on the manufactured product vs. those of competitors. This type of testing requires a large number of consumers representing a good cross section of the population.

In the panel difference method, a small group of individuals is trained to act like an instrument in describing attributes of processed products. Panelists might be screened by their ability to detect the four senses of taste: sour, sweet, bitter, salty and their individual threshold levels for specific flavor or odor compounds. The particular method of flavor or odor evaluation depends on the product and its characteristics, the target market and the flavor or odor components of interest. A number of product difference test exist, including: paired comparison, triangle, dilution, ranking, numerical scoring, descriptive and flavor or odor difference methods.

Enzymes

Enzymes are proteins which occur naturally in plants, animals and microbial cells and are important because they catalyze both desirable and undesirable reactions. For example, enzymes catalyze many of the color, flavor and textural changes associated with ripening fruits and vegetables. The enzyme polyphenol oxidase catalyzes browning of senescent and cut products such as mushrooms, bananas, apples, lettuce and many other commodities. Lipoxygenase catalyzes off-flavor and off-aroma production during frozen storage of vegetables unless they are adequately blanched. Most enzymes are inactivated by a short heat treatment (typically to 80°C), therefore most horticultural commodities are either blanched or otherwise thermally processed to prevent deleterious reactions catalyzed by enzymes during distribution and storage. Enzymes may also be inhibited by the use of certain chemicals or the exclusion of oxygen.

In order to evaluate the activity of enzymes important to a particular product, it may be of interest to evaluate activity in the raw and processed products. Analysis of enzyme activity normally involves blending a known weight of the product in water or buffer, filtering or centrifuging to remove particulate material, and using a colorimetric measurement to evaluate the reaction of enzyme and substrate. One may measure substrate consumption or product formation to track enzyme activity.

Additional Reading

Food and Agricultural Organization. 1981. Manuals of Food Quality Control, 5 volumes, Food and Agricultural Organization, Rome, Italy.

Gould, W.A. 1983. Food Quality Assurance, AVI Publishing Company, Inc., Westport, CT.

Kramer, A. and B.A. Twigg. 1979. Quality Control for the Food Industry, AVI Publishing Company, Inc., Westport, CT.