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FOOD PROCESSING SERIES

Reducing Fresh Produce Loss Due to Disasters and Pandemics

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Introduction

Disasters and pandemics can cause serious damage to the economy and lives of people. The mitigation efforts and social distancing recommendations that have impacted nearly everyone are indeed necessary to slow and eventually stop the spread of the virus that causes COVID-19.

As expected, supply chains have been disrupted. Due to the essential nature of food manufacturing, major food companies have managed to continue producing under very strict conditions. However, this is not the case for the entire food supply chain. The side effects of current virus mitigation efforts have closed restaurants and left farmers struggling to find outlets to sell fresh produce before it must be destroyed.

Agility is one of our values at Purdue University, the Department of Food Science and our Extension program. It has been our intent to bring science and economics together to develop immediate and affordable solutions for small and struggling companies. In this article, we introduce a simple process – and provide a step-by-step method – to potentially convert produce to a retail-ready, shelf-stable product and create value-added incremental income by reducing waste and increasing the shelf-life of the raw materials.

Also, farmers and small business owners may be able to leverage governmental loans for the production of food products.

Problem Statement and Proposed Solution

Two statements summarize this article:

- Value-added production can be achieved by converting low-cost raw material. As we've seen, a disaster or pandemic can quickly lead to reduced

demand for raw materials, including fresh produce. But raw materials not (temporarily) being sold to restaurants, grocery stores, and other manufacturing companies can potentially be thermally processed and sold through the regular retail chain. There is no need to add preservatives, and they would be clean-label products, if desired. These shelf-stable products can last up to one year or more.

- An alternative supply-chain solution can reduce waste and extend the shelf-life of produce. With mild processing steps, similar processed products can be created for the cold-chain market to increase the shelf-life of the products. However, certain steps are necessary to ensure the safety of the food.

In this article, we look at acid foods and acidified foods. The term pH is used to measure the acidity of a food product. A product that has natural pH lower than 4.6 is classified as an acid food, and the products that have pH equal or higher than 4.6 are classified as low acid food. If acid is added to a low acid food to achieve a finished equilibrium pH lower than 4.6, it is classified as an acidified food (e.g., tomato, corn, and beans salsa).

Path-forward to achieve these objectives

This is a simple demand-supply equation. When the demand projections are disrupted, there will be a surplus of certain produce, and the cost goes down significantly. In this case, new demand opportunities need to be created as alternative outlets. This situation is not limited to the current pandemic situation. Disruptions are always possible.

This can be considered as a great opportunity for producers to try to develop value-added product development and additional income opportunities while supporting the economy and minimizing waste. Regional raw material producers, including farmers, can harvest produce and take their fruits and vegetables to local co-manufacturing facilities or certified kitchens for production.

Simple recipes or formulated products, such as salsa or straight puree, can be prepared with the help of Purdue University or through various contract manufacturing resources.

Keep in mind that products with a pH higher than 4.6 can also be commercially manufactured, but products with pH values lower than 4.6 are easier to develop and package. The pH of the products can be checked with a pH meter. Either send your products to our laboratories at Purdue University, Food Science Department (see Contact Information/Rhonda Taylor) or to certified local labs.

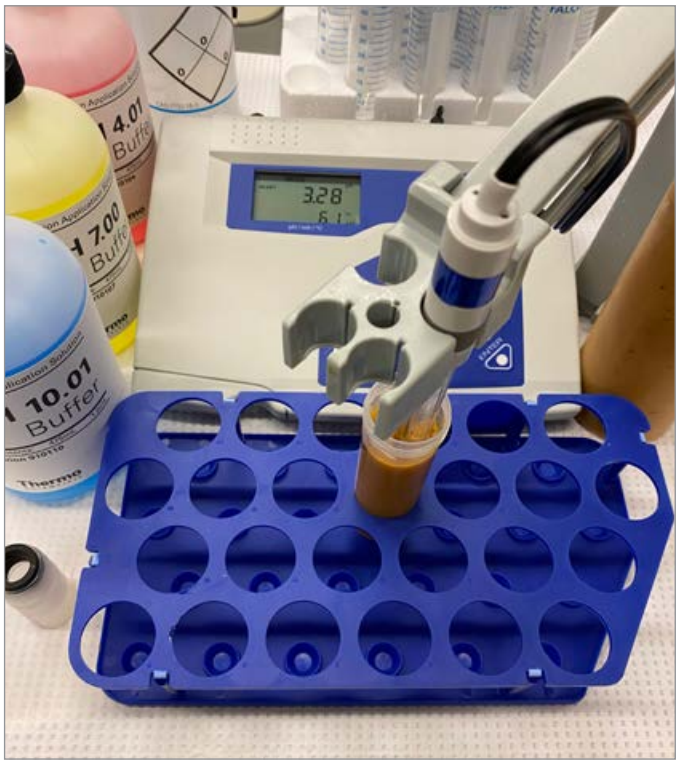

Figure 1. *Measuring pH of a product with a pH probe.*

Hot-Fill-Hold Food Processing

Step-by-step process

1. **Formulation and Package:** Develop recipes (sauces, soups, salsas, etc.) that potential consumers want to purchase at groceries, online marketing channels, and farmer markets. Some non-potentially hazardous products can be made and sold at a farmers market by a home-based vendor (HBV). However, products sold at retail must be produced in a commercial kitchen or a commercial contract manufacturer. For consistent production, the ingredients should be defined as a percentage of an overall batch quantity. This will ensure that your product receives the proper thermal process for the safety of consumers. It is also critical to determine the type of package (e.g., glass jars, metal cans, plastic jugs). The recipe, package, and processes can be developed at a home kitchen or a commercial kitchen with or without Purdue University's guidance. Once satisfied with the product recipe, package, and process, proceed to the next steps.
2. **Contract Manufacturing (CM):** Contact the co-manufacturing location. There are several certified kitchens and co-manufacturing locations around the state. Depending on the formula and package specifications, technical resources at CM locations would be able to help with the capabilities to produce

such a product. Modification of the formula, package, and process may be needed to scale up and get the product to a commercial scale.

3. **Process Letter:** If the product is not a naturally "acid" product (pH is naturally less than 4.6 without the addition of any acidulant), the product is classified as "acidified" and the process needs to be packed at a Food and Drug Administration-registered facility. A process letter from a competent Process Authority (PA) must also be submitted along with FDA filing documents. The PA can make the determination of the category as acid or acidified food. Prepare FDA documentation (if necessary) according to the U.S. FDA regulations outlined in Code of Federal Regulation (CFR) Parts 108, 110 and 114 and local requirements.

4. **FDA process filing:** Acidified products need FDA filing before you can commercially produce such products. Your PA can help you file the product, or your co-manufacturing location can file the product. The FDA filing forms are either online or paper-based; links are provided below. The filing must contain all the critical factors listed in the PA letter. FDA recommends online process filing for faster processing, especially due to COVID-19.

5. **Batching:** There are phases of product development. The formula can be developed on the countertop for flavor and texture development, develop process and packaging in the pilot scale, and excel in the production level. If there are any dry ingredients, such as beans, they must be hydrated to certain moisture content before being mixed with other ingredients. The hydration process ensures two things: 1) it helps in achieving the thermal process, as moisture helps with driving the temperature to the core, and 2) it helps achieve the defined equilibrium pH to reduce the food safety risks.

6. **Heating:** Jacketed heated kettle or continuous heat exchangers can be used to bring the product to the specified temperature as defined in the process letter. There must be a predetermined hold time at the specified temperature. The product can then be sent to the filling hopper. The temperature in the hopper should not drop below the minimum specified in the process letter.

7. **Filling:** Rinsed jars or some other packaging types can be filled with the hot product from the filling hopper. The hot product will sterilize the internal contact surfaces of the jars and closures

8. **Sealing:** Packages such as jars, jugs, or cans are sealed with a special closure (e.g., screw caps or lids) to provide a hermetic seal (airtight seal). This

Figure 2. *Steam jacketed kettle with a mixer to stir the product while cooking and holding for specified time and temperature.*

is one of the most important steps. If the seal is not applied correctly, there will be contamination of the product from the outside environment and will create a potential food safety hazard. The hermetic seal also creates an anaerobic environment inside the jar that has the potential of creating an environment (if for some reason pH exceeds 4.6) favorable for Clostridium botulinum growth. Clostridium Botulinum produces a neurotoxin that causes botulism and can be lethal for consumers.

9. **Hot-Hold period:** Once the capping process is done, the containers should be inverted to sterilize the internal surfaces of the cap and headspace. The inversion time should be followed as per the process letter. After inversion time, the containers should be held upright and until the hold time is reached.

10. **Cooling:** After sufficient hold time has been achieved as per the process letter, the containers should be cooled down either with water or regular cooling tunnels.

11. **Distribution:** After the containers have been cooled, the label can be applied on the dry container surface. This product can now be stored in a warehouse, shipped to your local grocery stores or marketed online.

Additional Thoughts

Food safety is critical. Contract manufacturing facilities follow the Hazard Analysis and Critical Control Point (HACCP) guidelines. Documentation of critical parameters needs to be taken care of for daily production and release of the product. General plant sanitation is important to keep the pathogenic-and spoilage-causing microorganisms out of the facility and your product. The hot-fill-hold process inactivates the pathogenic vegetative microorganisms such as Salmonella, Listeria, and E. coli. However, post-process contamination must be avoided to keep the product safe for consumption. The hot-fill-hold process also inactivates the spoilage causing microorganism and provides the product longer shelf-life at regular temperatures of distribution and storage.

Example product and process

An example is provided in the table below for a product and its associated process. This should not be used for commercial processes and is for example only.

Process Information for Hot Salsa	
Formulation	Tomatoes, jalapenos, salt, sugar, vinegar
Equilibrium pH of Product*[a]	4.10
Process Temperature*	189 ºF
Process Time*	5 minutes
Fill Temperature	185 ºF
Hold Time*	59 minutes (with inversion of 20 seconds)

*Denotes critical operating parameter
[a]Equilibrium pH measurement according to 21 CFR Part 114.90(6)

Links

https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=114&showFR=1

https://www.fda.gov/food/registration-food-facilities-and-other-submissions/establishment-registration-process-filing-acidified-and-low-acid-canned-foods-lacf

https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=fea036e06a37182d500ccc0211adee50&mc=true&r=PART&n=pt21.2.108

https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=fea036e06a37182d500ccc0211adee50&mc=true&r=PART&n=pt21.2.110

https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=fea036e06a37182d500ccc0211adee50&mc=true&r=PART&n=pt21.2.114

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