Testing, Cumulative Science, and Math Used in Pressure Canning

What the research and testing tells us

Index

The Birth of Home Canning

Learn the History of this time-honored craft and those who perfected the science and math

“An army marches on its stomach.”

Emperor Napoleon Bonaparte

A War Era & Science

Home canning, or jarring as they say in Europe, dates back prior to the Napoleon War era (1803 -1815).

The birth of food preservation known as home canning, wasn't "invented in America" by way of the USDA. It **started in 1792** and was catupulted to the forefront by a dooming loss.

Napoleon was losing the war on the front-line because his men were without food; and without food, his men couldn't sustain. But why were they without food?

After fresh foods **traveled** all the way from his kingdom to the front-line, the foods would arrive **rotten and inedible** leaving his men to pillage or purchase whatever the native country offered as a food source.

The Contest

Napoleon put it to his people, through the Society for the Encouragement of Industry, whomever could find a way to **preserve large quantities of food** to sustain their soldiers, this person would receive a 12,000 franc reward.

The Winner

Nicholas Appert, a chef, confectioner and distiller, collected the prize in 1810, after he spent 14 years experimenting so he could learn how food cooked within a glass jar would not spoil unless exposed to oxygen. He **developed a method of jar sealing** and successfully preserved soups, fruits, vegetables, juices, dairy products, marmalades, jellies, and syrups.

With his award money, he developed the first commercial cannery, the House of Appert, which operated from 1812 to 1833.

How the 3 Pillars were Discovered

Time, Temperature & Acidic Value

Fast forward 50 years. It was Louis Pasteur who discovered how **time, temperature and acidic value played a vital role** in protecting us from harmful microorganisms by outlining how to properly process foods.

It was Pasteur who was able to prove why food spoils and why beer and wine sour which is due to microorganisms and foodborne pathogens. He therefore invented pasteurization.

Pasteurization destroys microorganisms by heating beverages and foods, then allowing them to cool. Simply put, boiling water destroys germs – **a process still used to this day**.

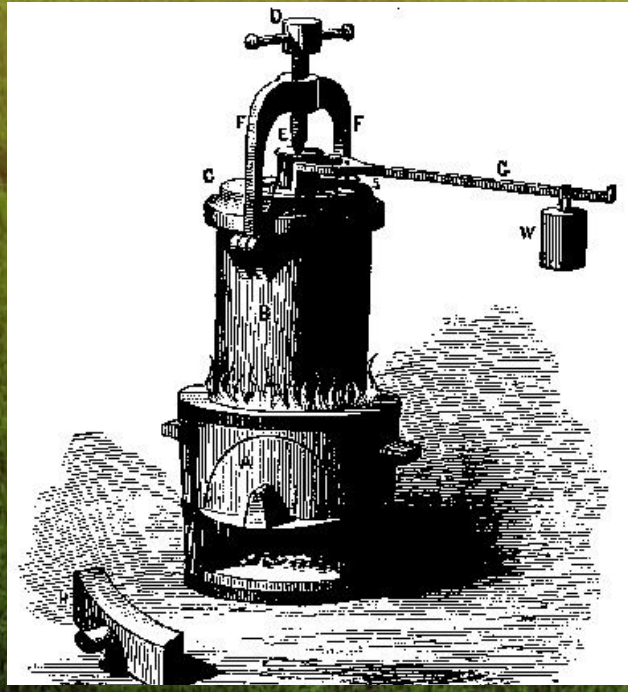
02

The History of Pressure Canning

Learn who created the first pressure cooker and how countries embarked on commerical and home canning food

Denis Papin was a French physicist, mathematician and inventor, best known for his pioneering invention of the steam digester (pressure cooker) in 1679.

Denis Papin, (born Aug. 22, 1647, Blois, Fr. —died c. 1712, London, England



The steam, or bone, digester was a closed vessel with a tightly fitting lid that confines the steam until a high pressure is generated, raising the boiling point of the water considerably. A safety valve of Papin's own invention prevented explosions.

It was a device created for extracting fats from bones in a high-pressure steam environment, which also renders the bones brittle enough to be easily ground into bone meal.

High-pressure cooker invented by French physicist Denis Papin in 1679

When did Pressure Canners focus on food preservation?

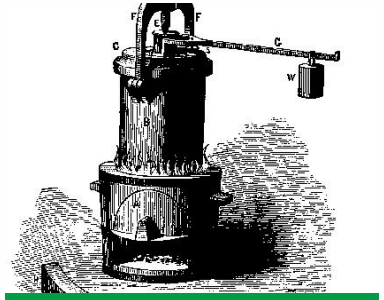
- **1864**: Georg Gutbrod of Stuttgart Germany began manufacturing pressure cookers in Europe made of tinned cast iron.
- **1890**: Archibald Kenrick & Sons in England manufactured a 6-quart pressure cooker.
- **1905**: Northwestern Steel and Iron Works in Wisconsin manufactured commercial retorts for food industry and hotels.
- **1915**: **National Pressure Cooker Company manufactured pressure canners for preserving food at home in the USA.**
- **1917**: USDA determined pressure canning was the only safe method for low acid foods in America.
- **1918**: Spain granted a patent to Jose Alix Martinez for the express cooking pot pressure cooker (sold with a cookbook of 360 recipes).
- **2020**: Presto creates the first digital pressure canner which meets the USDA guidelines established in Bulletin No. 930.

Timeline

Evolution of pressure canning

Spanning the globe, enjoy a breif timeline sharing the inventors and companies who made pressure canning what it is today.

A vital solution to safe long-term food storage.



First digestor created

1697
Denis Papin

1812
Nicholas Appert

House of Appert cannery

Pressure canners mfg

1864
Germany

1905
Wisconsin, USA

First home use pressure canner

2020
Wisconsin, USA

First commercial retort

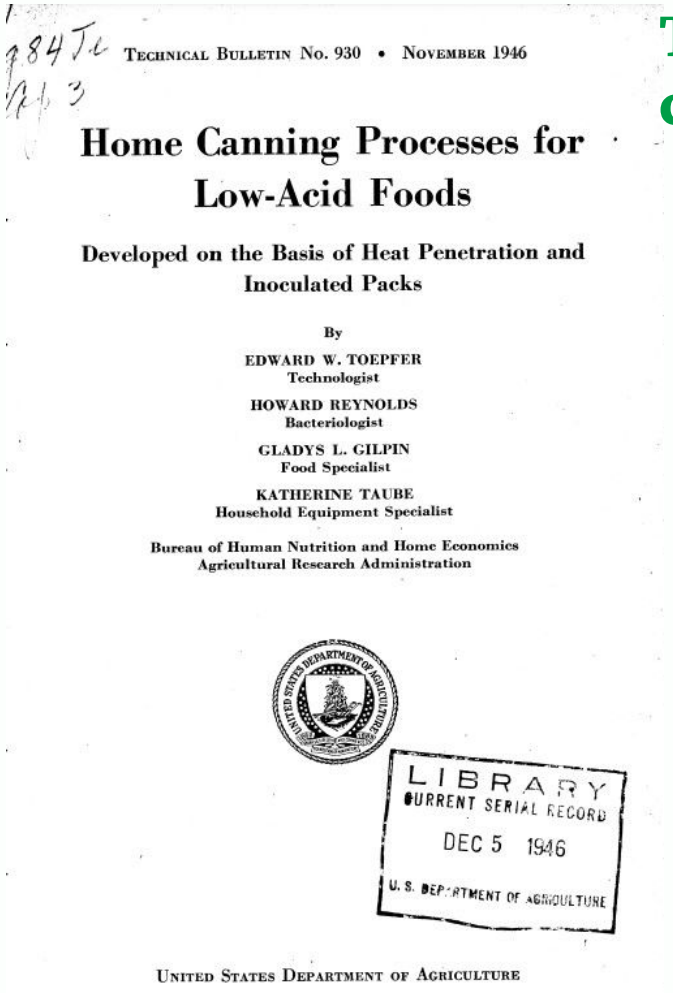
1915
United States

Digital pressure canner

03

Today's Standards

Learn how the United States established guidelines and recommendations for home canners to create the canning methods used today.



TECHNICAL BULLETIN No. 930 • NOVEMBER 1946

Home Canning Processes for Low-Acid Foods

Developed on the Basis of Heat Penetration and Inoculated Packs

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The rationale, research and testing of home canning in the United States

Calculations from heat-penetration data and the destruction of spores of heat-resistant bacteria have served to establish processes for the commercial canning of low-acid foods since 1905.

In 1918 to 1921, attention was focused on the problem of numerous outbreaks of botulism caused by commercially canned products. The food industry then recognized the prime importance of canned food process studies.

In 1915 when home canners became readily available for consumer use, outbreaks of botulism caused by home-processed foods occurred at the rate of 10 to 12 per year due to faulty and careless canning techniques. Home canning processes were largely derived from arbitrary extension of commercial processes; however, they did not take into account the differences in methods and equipment.

So, research was conducted in 1945-1946 to give home canners a guideline and here is what was learned...

1

Tin cans vs Glass jars

Using glass jars when home canning produces a slower heating and exhausting time which is much different than commerical tin or aluminum cans.

2

Longer Cooling Time

Home canned foods take much longer too cool after the jar is removed from the pressure canner. This increased sterilization effect contributed signifcantly to the lethal vlues of processing; meaning, the cooling period is still heating and killing harmful organisms.

3

Over Processing

Even with food temperatures being low and the canner and canner water being cold at the start, the results indicated that home canning processes at 250°F may be more severe than necessary. The reserach concluded and recommended a reduction in processing times for vegetables in pint jars.

Three valid discoveries during testing which helped improve the food quality and safety of home canning low-acid meats and vegetables

Innoculation & Heat Penetration

Test organism: Putrefactive anaerobe No. 3679

The **researchers inoculated packs of vegetables and meats** in pint jars with spores. Approximately 30,000 spores injected into meat and 10,000 spores injected into vegetables. Control jars without spores were also processed.

Using preliminary heat-penetration data, researchers chose three processing times to study at 250°F **later realizing the temperature was greater than required**.

Lowering the processing time to 240°F and using quart jars, times of 60, 80, 90 and 100 minutes were tested. The jars were then **stored for 4 months** at an excessive temperature of 98.6°F.

All spoilage of inoculated jars occurred during the first month of incubation and none during an additional 18-month holding period at room temperature. No control jars spoiled. Inoculated jars of meat processed for 60 minutes all spoiled, some at 80 minutes spoiled and **no spoilage occurred among jars processed at 90 and 100 minutes**.

+ info

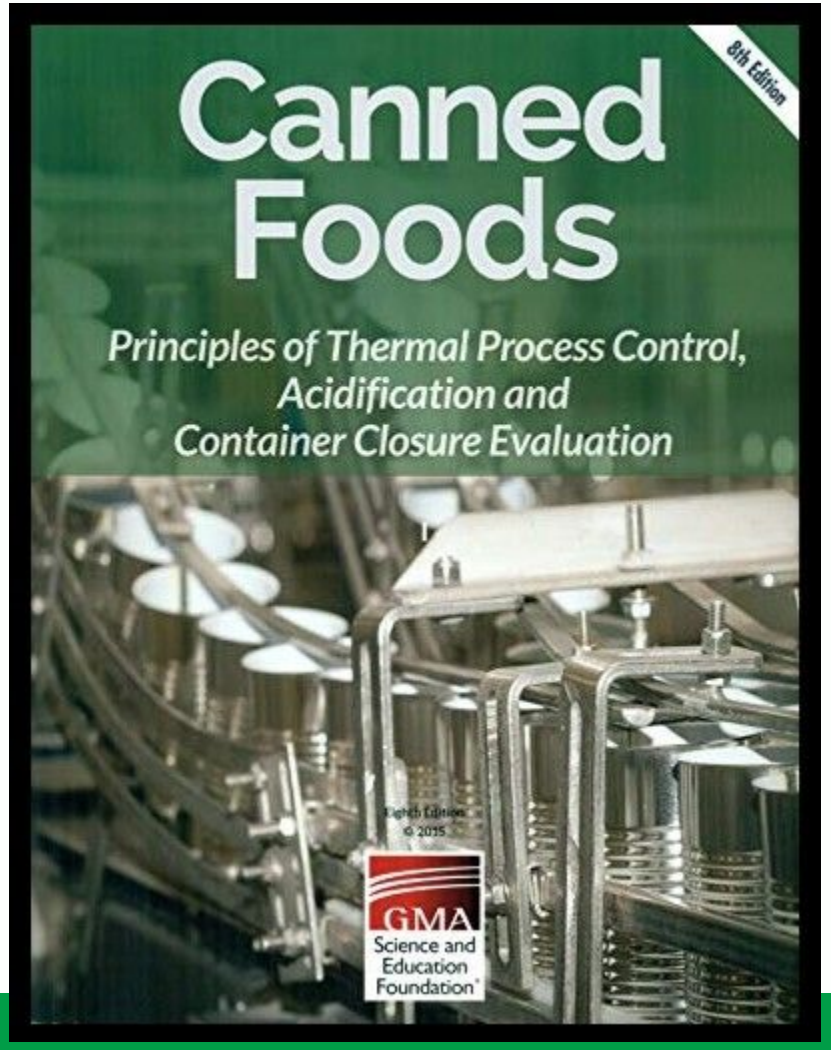
Outcome

It was after such riggerous testing the guidelines for home processing of low-acid foods (meat and vegetables) were established.

It is why today we see the common processing of low-acid meat recipes give the following instruction:

> Process at 10 PSI, 75 mintes for pints and 90 minutes for quarts.

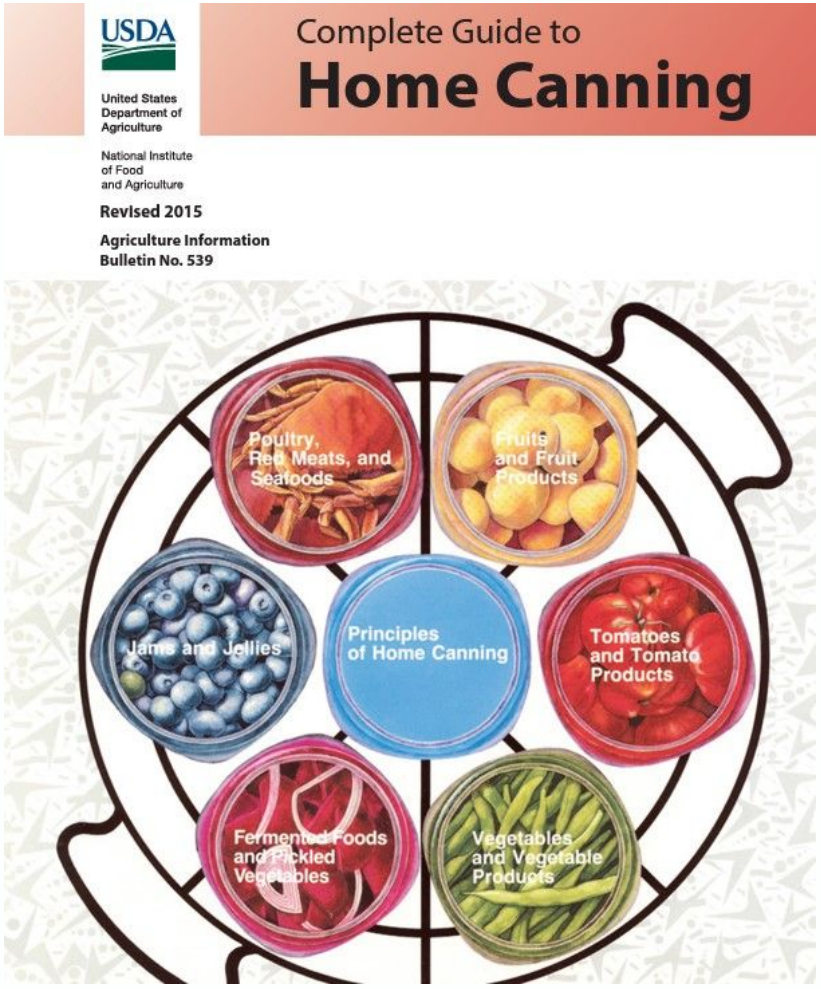
It is also why pint jars process for shorter times than quarts - thankfully.



Today's Principles and Commercial Standards

In 2015, the 8th edition of the Canned Food Manual reflected several significant changes brought about by new FDA regulations in the commercial canning industry. This manual is used to instruct and train retort operators, processors and inspectors in the commercial canning industry.

Later, the FDA established additional regulations detailed in Title 21 Section 113 and 114 relating to the proper processing and storage of both high- and low-acid foods in a commercial environment.



Today's Home Canning Guidelines

In the 1908s, the creation of an Extension Service Center for Excellence at the Penn State University made it possible **to conduct the research necessary** to revise four previously published bulletins for home canning: USDA Home and Garden Bulletins: Number 8—"Home Canning of Fruits and Vegetables"; Number 56—"How to Make Jellies, Jams, and Preserves at Home"; Number 92—"Making Pickles and Relishes at Home"; and Number 106—"Home Canning of Meat and Poultry.")

In 2000, the National Center for Home Food Processing and Preservation was established as a cooperative effort of the National Institute of Food and Agriculture (formerly the Cooperative State Research, Education, and Extension Service) which is **the hub for the college extension offices** across America.

This bulletin and those prior **still use the foundational math and data ascertained and published** in the Technical Bulletin No. 930 from November 1946. Sadly, university funding continues to be an issue so many canning recipe creators **hire independent laboratories** to test new recipes using the same heat penetration and thermal processing standards from 1946.

04

Commercial Processing Applied

What we learned throughout history to develop standardized processes for manufacturing and how they are used by home canners in the 21st century

04

Commercial Processing Applied

What we learned throughout history to develop standardized processes for manufacturing and how they are used by home canners in the 21st century

Excessive Heat Destroys Quality in Commercial Canned Foods

Excessive Heat Exposure in Blanching

Since heat destroys many quality factors, limiting the time of exposure makes sense from a quality standpoint. One of the first things that comes to mind is the elimination of the blanching step in fruits and vegetables. After all, the high heat during pressure canning is sufficient to inactivate the enzymes.

+ info

While that is true, there are important reasons for blanching:

1. Blanching prior to retorting serves several purposes. Most importantly is removes tissue gases. This increases the level of vacuum in the container and reduces the amount of oxygen present, both of which extend the shelf life.

2. Additional blanching softens the product, which facilitates filling and acts as a preheating step prior to retorting.

How Pre-Cooking a Recipe Helps Home Canners

How Canners May Eliminate Blanching

Where home canners excel is by pre-cooking the recipe prior to filling jars eliminating the need for blanching. Pre-cooking a canning recipe for a minimum of 5 minutes expels the tissue gases (trapped air) which:

1. Pre-shrinks foods so we yield more recipe per jar,
2. Softens the food making it easier to digest,
3. Increases the level of vacuum in the container,
4. Reduces the amount of oxygen present, and
5. Extends the shelf life.

+ info

1

Crab, Clams, Oysters

Detailed instructions and processing times have been established. Even making stock from shells have been tested and explored.

2

Canning Seafood

When canned correctly, seafood products are high in quality and safe to eat. It is important to pack and process seafood as directed to guarantee safety.

3

Processing Times

You will notice a change in processing times when home canning seafood and tuna. They are longer, upwards of 110 minutes. Times are also different for shrimp, crab, clams and oysters. Fish and tuna have a low acidic value compared to red meat and poulty so it processes longer.

05

Thermal Heat Processing

How the science of using time and temperature play a vital role in making low-acid food shelf stable

the process value represented by an F_o which is 2.6 times the standard error of estimate below the mean observed F_o. Assuming normal distribution of observed F_o values, expected values would not fall below that limit more than once among each 200 containers of food processed.

The above outlined choice of a lower limit for process values which on the surface allows for over-all spoilage of 0.5 percent would be highly questionable in the absence of other safety factors. The more significant of these factors are the heat resistance of the test organism and the technique of the inoculated-pack checks on calculated processes.

While information is very limited, there is good reason to believe that the spores of the test organism, putrefactive anaerobe No. 3679, are of definitely greater resistance than those of commonly encountered soil forms which might cause spoilage. Conn (*9*) noted that soil suspensions heated at 85° C. for 15 to 20 minutes gave spore counts averaging approximately 50 percent of counts made after heating suspensions at 75° for the same periods of time. These results indicate a low order of heat resistance for the spores of many soil forms. Tischer and Esselen (*29*) reported thermal-death times of four organisms isolated from spoiled low-acid foods. All had F values below that of No. 3679 in phosphate buffer at pH 7.0 and in two foods.

That the test organism in the concentration used exhibits greater resistance than is characteristic of normal contamination is also shown by the results reported here. Of a total of 653 control jars of meats and vegetables processed as part of the inoculated packs, only 1 jar spoiled, even after short processes which permitted gross to 100 percent spoilage of inoculated jars (tables 4 and 7).

In addition, the number of spores used for inoculated packs was somewhat in excess of the normally expected natural spore load. The choice of inoculum and its concentration by placement at the slowest heating point of the container, thus insuring maximum probability of survival, constitute additional safety factors.

Processes recommended on the basis of these investigations are presented in table 10 along with those previously recommended by the United States Department of Agriculture and by commercial processors. In every instance processes for vegetables in pints are shorter than those previously recommended. For quarts, however, the data obtained have led to the derivation of longer processes in a few instances and over-all process reductions have not been as great as for pints. This is probably related directly to packing and processing techniques. The data of table 8 show that the initial temperatures of quart packs were generally below those of pints. The effect of lower and more variable temperatures and other factors affecting

Higer Temp Can Mean Shorter Processing Time

When compared with water bathing

Pressure canning can also be used for high-acid foods like fruit. Doing so speeds up the processing time. For example, Basil Diced Tomatoes recipe would require 50 minutes in a water bather, yet only requires 15 minutes in a pressure canner at 10 PSI. Pressure canning fruit like Pineapple Chunks in quarts takes 20 minutes in water bath, yet only 5 minutes at 15 PSI helping to retain the integrity of the pineapple and its nutrients.

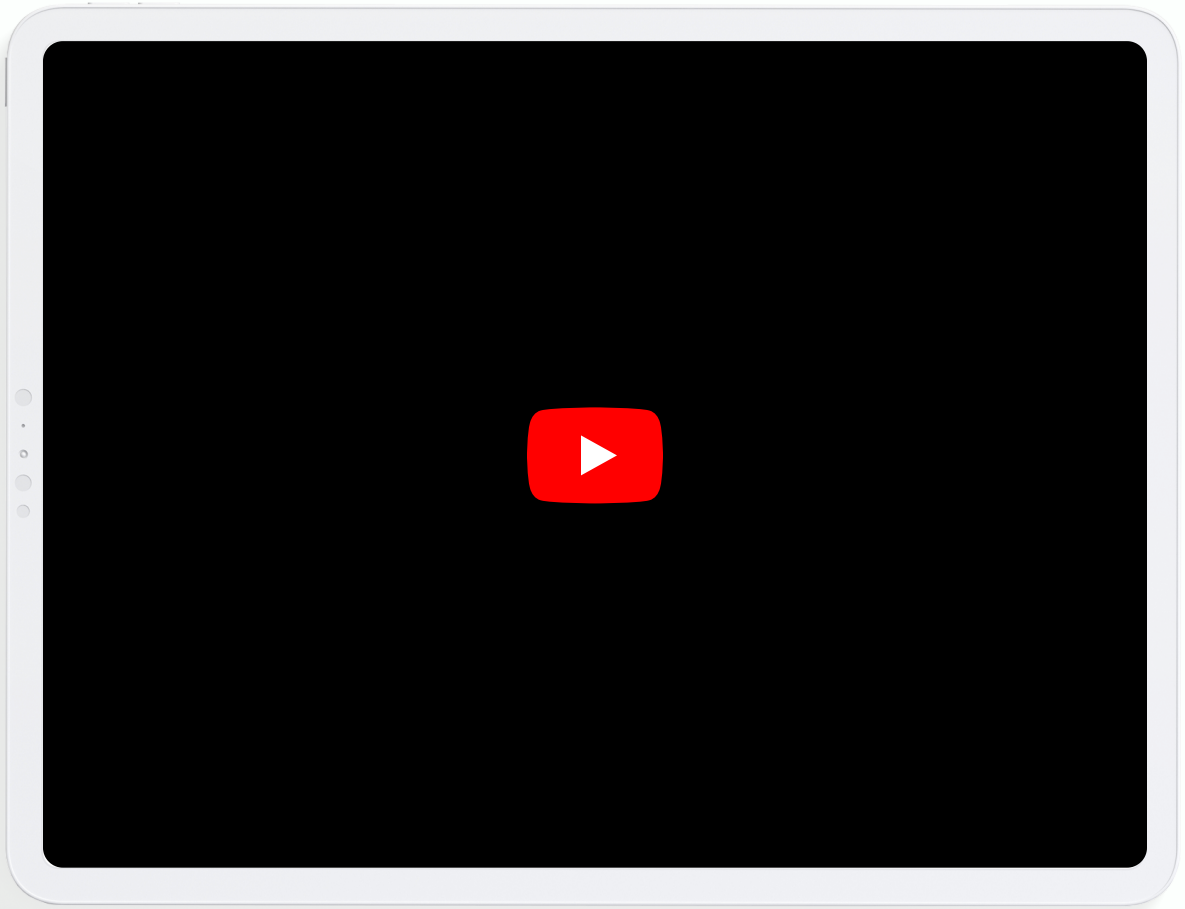
Over Innoculation

The data errs on the side of caution

As stated in the 1946 Bulletin 930, the spores produced for the expeirment to innoculate the samples are more resistent and in excessively larger quantites than actual spores found naturally in soil or water. The test organisms were also placed at the slowest heating point to ensure probability of survival. So processing times in the research are longer than necessary. This padded room for home canners can be viewed as added safety.

Inspecting the Pressure Canner

The Canning Diva® provides tips on how to properly inspect your pressure canner prior to using. Take a quick look at 3 key components to ensure your canner operates safely and efficiently!



06

How Jar Cooling Plays a Vital Role

Researchers discovered something amazing when comparing home canning in glass jars with the use of aluminum cans in commercial processing

Allow Jars to Cool

this decreased processing time

Prior to the 1946 research, the value of the cooling period for glass jars of food was overlooked. It was learned it is an extra process where cooler spots became hotter and additional organisms were killed.

Less Lid Failures

natural vacuum seal

Allowing your processed jars to cool naturally, undistrubed, expresses cool air out and forces the lid to seal onto the jar rim. Give your jars upwards of 8 to 12 hours to seal before moving.

Slower is Better

glass jars just take longer

Foods home canned in glass containers under steam pressure take a long time to cool, which is still part of the processing, or sterilzing of the food. To rush it could cause bacteria to grow.

07

Significance of Proper Storage

Safety doesn't stop at processing and cooling. It is imperative we store our home canned goods properly or bacteria may grow and spoil the foods.

Learn the proper storage conditions so you may keep your home canned goods safe while increasing their shelf life.

Follow these Storage Tips for Longevity

1. Remove rings, wash jars with hot soapy water
2. Label lids with date and recipe name
3. Store between 50°F and 70°F for BEST quality retention, never above 95°F
4. Low to no humidity
5. No direct or in-direct sunlight
6. Never in cupboards above appliances
7. Never directly on cement floors
8. Limited Storage Space? Try these options:
    a. Linen and coat closets
    b. Under beds
    c. Rarely accessed kitchen cupboards
    d. Under stairs

Lifespan

How long will my home canned goods last?

If your home canned goods are processed and stored properly, and the lid remains sealed, your home canned food will have upwards of 3 to 5 years longevity.

High-acid products will last longer but lose their integrity faster. Low-acid foods will keep their integrity but decrease in nutritional value a bit faster.

Each year the nutritional value decreases. Here's how I look at it; if we can eat junkfood and desserts which have no real nutrition, I am content eating my home canned recipe after 4 years even if its overall nutrtional value drops in half.

I know what when into each jar and likely grew many of the ingredients myself.

Thank you!