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Using the Flexible Retort Pouch to Add Value to Agricultural Products

Soojin Jun,[1] Linda J. Cox,[2] and Alvin Huang[1]
Departments of [1]Human Nutrition, Food and Animal Sciences and [2]Natural Resources and Environmental Management

Hawaii's diverse agricultural production sector is the basis of its growing food-processing industries, which provide a variety of unique products to both residents and visitors. In 2000 the food-processing sector contributed $1.07 billion to Hawaii's economy, in addition to the $1.94 billion that came from agricultural product sales (source: Hawaii Agricultural Statistics Service). Hawaii's food processing industries include pineapple processing, sugar processing, canned vegetables and fruits, confectionary products, salted and roasted nuts and roasted coffee, meat products, milk products, grain and bakery products, and beverage products. Many agricultural industries, such as the beef industry (Cox and Bredhoff 2003), are interested in adding value to their products with processing.

Food packaging options

Hawaii's geographic isolation presents a challenge to exporters interested in competing in the global market and makes improvements in product shelf life and stability a top priority for food processors. Canning, one of the most common packaging methods to preserve food products, requires a large capital investment in facilities for production, transportation, and storage. Because the materials needed to fabricate cans must be imported, rising fuel costs combined with the weight of can metal has made canning increasingly less cost-effective in Hawaii.

Consumers increasingly demand food products that have high-quality taste, appearance, and nutrition and, preferably, require minimal preparation time. For quality reasons, consumers often prefer frozen products to canned. This trend is especially important to the beef industry, because many beef cuts require extensive cooking time, as well as considerable processing expertise to maximize palatability. The inability of the beef industry or any other agricultural industry to adapt to consumer preferences could result in a loss of market share.

While high-value products such as coffee and macadamia nuts have been marketed in vacuum-packed pouches for many years, products that require cooking still have limited shelf life, even if vacuum packed. Cox and Bredhoff (2003) reported that retailers and wholesalers want beef products that have longer shelf life. At the same time, cattle producers face a challenge in selling the less desirable cuts and look to processing as way to standardize the quality of these cuts. Processed beef products desired by Hawaii residents and visitors include local-style beef stew, beef jerkey, beef *lau lau*, and *pipi kaula*, and these products offer potential for using and adding value to the less saleable cuts. If a better method can be found to preserve these products, overseas markets could become more accessible, because consumption would not be limited to people currently in Hawaii. Marketing processed products would also eliminate the challenges faced by a fresh beef product, such as bans resulting from outbreaks of BSE (bovine spongiform encephalopathy).

One solution that offers promise is a new packaging technology, the retort pouch, a flexible, laminated package that can withstand thermal processing temperatures and combines the advantages of both metal cans and plastic packages (Fig. 1). In the 1950s, the U.S. Army developed the pouch to replace heavy metal cans with lightweight, easy-to-pack, shelf-stable food containers for packaging combat rations. In 1965, the first com-

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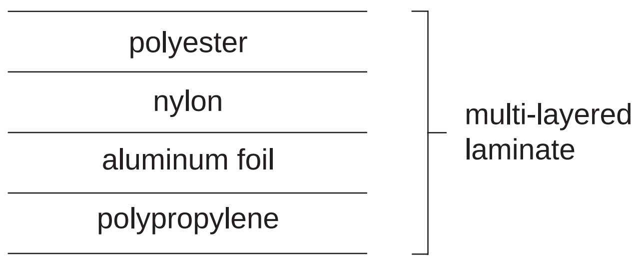
Figure 1. Examples of commercial retort-pouched products.

mercial retort pouches were produced in Italy. Research on the development of large-scale facilities continued through the late 1970s to produce “Meal Ready-to-Eat” (MRE) units for the U.S. military. In Japan, retort pouch technology has been widely accepted, and a variety of pouched products, ranging from sukiyaki to soup, is available.

Most retort pouches are constructed with a four-ply laminate consisting of a polyester outside layer, a nylon second layer, an aluminum foil third layer, and a polypropylene inner layer (Fig. 2). The melting point of polypropylene polymers is around 138°C (280°F), which is higher than the commercialized sterilization temperature of 121°C (250˚F). The aluminum foil can be laminated with either the matte or the shiny side exposed to view. Some pouch material contains polyvinylidene chloride (PVDC, or SARAN®), ethylene vinyl alcohol (EVOH), or nylon instead of aluminum foil as a middle layer. The components of the laminate are held together with adhesives, which are usually modified polyolefilms such as ethylene vinyl acetate (EVA). Each component performs a specific function that is critical to the shelf stability and container integrity. In some cases a clear layer, to permit viewing of the product, replaces the foil layer, by using SARAN® (PVDC), EVOH, or nylon. While these plastics are good barriers to oxygen molecules, they are not complete barriers, and therefore the shelf life of the non-foil container is reduced substantially.

Figure 2. Cross-section of a retort pouch.



Advantages of the retort pouch

Retort pouches have several advantages over cans (Table 1). Flexible pouches are more economical to ship and dispose of than rigid cans. The retort pouch–packed product needs significantly less heat than cans to achieve commercial sterility, with cooking time and energy costs reduced by half. Heat penetrates the food much more quickly when it only has to reach the inside of a half-inch-thick mass rather than the much thicker mass in a round can. Unlike canned foods, the pouched foods will not be overcooked and softened into mush, ensuring better texture and taste. Retort pouches of low-acid, solid foods have attained commercial acceptance, and as the

Table 1. Advantages of retort pouches vs. metal cans.

Features of retort-pouch packing	***Benefits***
Reduced cooking time	Better taste, nutritional value; faster turn-around time
Complete product evacuation	Improved product yield and consumer value
Reduced bulk and weight	Lower transportation and storage costs
Environmentally friendly	Less waste and fossil fuel consumption
Package differentiation and larger shelf display	Increased sales
Package durability	Eliminate cuts and promotes employee safety
Rotogravure printing	More attractive graphics on packaging
Package durability	No dented cans

technology is more widely used and accepted, other heat-sterilized foods are expected to appear in pouches, resulting in a new, expanding segment within the packaged foods industry.

Seafood companies in the USA are packaging canned mackerel and tuna in retort pouches. They have concluded that the process time for retort pouches is significantly reduced, while product quality remains high. Smoked seafood that is vacuum packed in retort pouches does not require refrigeration and appears fresh and moist. Stability is accomplished by a heat process (above 230℉) under pressure, which destroys *Clostridium botulinum*, other illness-causing bacteria, and spoilage bacteria. Recently, Star-Kist offered food-service packages, followed by retail sizes, of tuna in a retort pouch, which has been a successful conversion from canned products.

Jack Link's "Fully Cooked Ground Beef" uses an aseptically sealed laminate pouch that keeps 10.6 ounces of 90-percent-lean ground beef "shelf-stable" for up to 18 months without refrigerating. The package is heat-sealed and the meat is fully drained, with no preservatives added, in "Mexican Style," "Lightly Seasoned," and "Italian Style" preparations. Currently, consumers eat about 75 percent of ground beef as an ingredient in "quick-fix" meals, giving this package a huge potential market. Smithfield's Esskay and Knauss Foods also both introduced creamed chipped beef in a stand-up, retorted pouch.

Ohmic heating of retort pouches

Retort systems require hot water or a steam-water mixture to cook the food, which is not particularly energy efficient. The author (S. Jun) and Dr. Sastry at Ohio State University have developed a pouch with conducting strips to warm food to about 80℃ and heat it to more than 121℃, hot enough for sterilizing. This makes a military-ration MRE pouch (Fig. 3) that does not require the chemical reaction, the hydration reaction of anhydride, for heating. Instead, these new pouches each have two tabs, like tiny ears, containing electrical contacts that are attached to a small heating unit, which generates pulsed electric power with various frequencies.

The electricity flows through the tabs, the electrodes, and finally through the product. The electric current flowing through the electrodes generates an electrical field that excites food molecules, causing them to vibrate and heat up. This is called ohmic or joule heating, just as an electric heater element heats up when current is passed through it.

The process results in fresher-tasting food with improved texture because it heats evenly from the inside out. The ohmic heating technique sterilizes a food product by holding it for a set time at 121℃ after a "come-up time" (CUT), the length of time required for the product to reach 121℃ (Fig. 4). The optimized CUT and holding time can vary depending on the food properties, targeted microbes, and packaging materials. Deter-

Figure 3. Flexible retort pouch with foil electrodes.

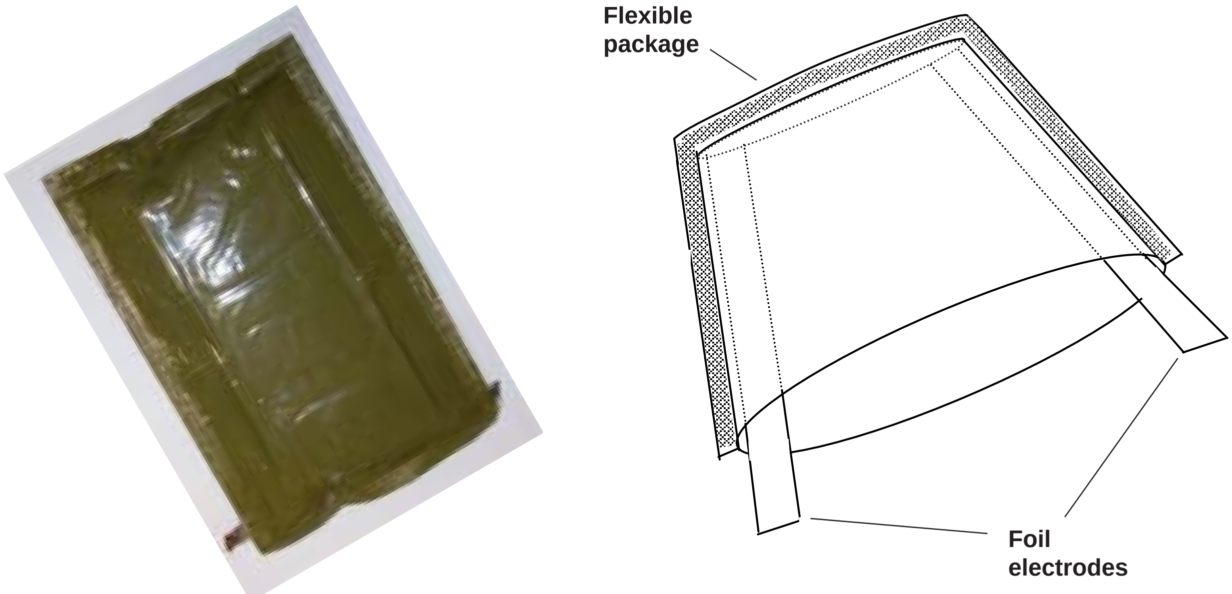


Figure 4. Heating pattern of the ohmic treatment.

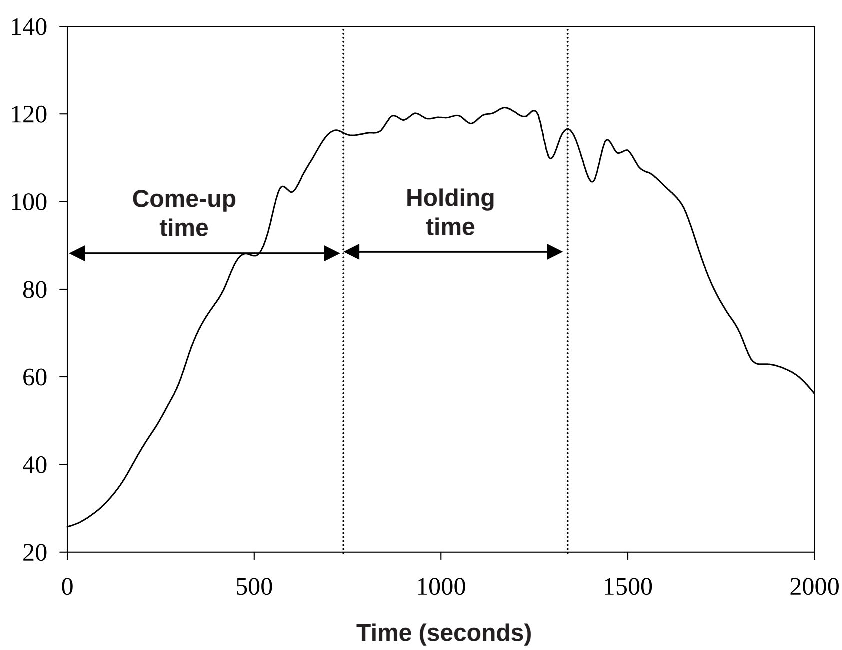
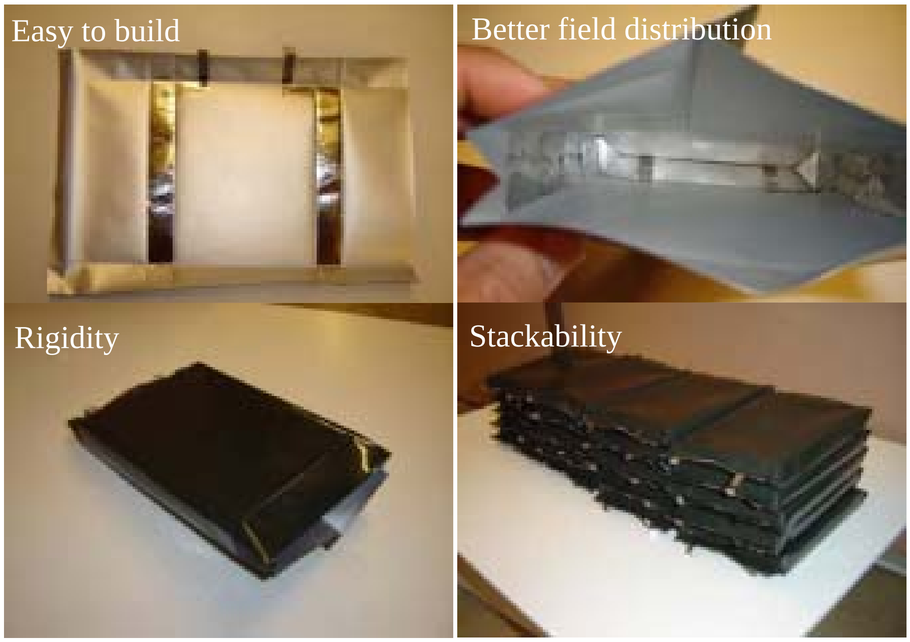


Figure 5. A new design of an ohmic retort pouch.



mining the optimal CUT and holding time for the specific product in question will require research.

The combination of plastic-foil packaging sponsored by NASA was intended to heat up space foods in packaging and reuse the packages to store or sterilize biowaste during long-duration space missions. Thus the pouches are likely to save space and weight on space flights, a critical consideration when the cost of boosting anything into orbit is about $10,000 a pound. The ohmic retort pouch holds promise as a way to cook packaged foods at the household level and at the mass-production level.

Looking to the future

Retort pouched products generally retail at a higher price than products in metal cans, and consumers appear to be willing to pay for the convenience and improved flavor and texture. Recently, non-foil retort pouches suitable for heating in a microwave oven have been developed, and the ohmic heating technique also has a potential for developing a heat-and-eat package. Figure 5 shows a newer design of ohmic retort pouch that heats more evenly and stacks more efficiently.

While the initial investment in pouching equipment is relatively expensive, pouch packaging technology is expected to be less costly in the long run than high-speed canning lines. For example, the Toyo Jidoki filling machine (Fig. 6) brings new levels of speed and versatility to food-packaging applications that require daily cleaning-in-place (CIP). This system is ergonomically designed to maximize its productivity to open, fill, and seal 250 pre-made retort pouches per minute, continuously. The actual cost of this stand-alone system is estimated at $0.9–1.3M, depending upon the specifications. What happens to the product before and after it goes into the pouch, such as premixing and labeling, along with whether liquids and solids are put into the pouch separately or together, affects the system requirements. The projected annual savings in a meat patty packaging operation, for instance, is estimated at $145,500. This means that the system will pay for itself in cost savings in about eight months.

While food processors are unlikely to remove a functioning can line to replace it with retort packaging, they

Figure 6. A high-speed retort pouch filler-sealer (Model TL-AX1, Toyo Jidoki Co.)

might be reluctant to put in new canning equipment or to replace one that has past its useful life. Machinery costs have declined as the consumer's desire for convenience increased. When compared with the expected benefits—i.e., a rapid return on investment—the initial capital investment could prove to be feasible.

The use of retort pouches for processed products holds potential for Hawaii's beef products and other foods that require cooking to ensure a long shelf life. Hawaii's consumers, including residents and visitors, will enjoy "ready-to-eat" convenience products quality-ensured by retort pouches. Some retort pouches that already have appeared in Hawaii markets, such as the TastyBite® line of "Cuisine of India" preparations, should be an inspiration to Hawaii's food processing enterprises. Given the cost of pouching equipment, however, industry coordination will be needed to provide economics of scale to ensure the feasibility and reduce the risk of adopting this technology. Agricultural producers will need to work cooperatively to maximize an investment in a pouching facility and to identify issues, such as food safety regulations, that need to be addressed during the adoption process.

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