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SANITATION PROBLEMS IN THE NEW PRESSURIZED FOODS[1]

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The amazing acceptance by the consumer of both the pressurized whipped cream container and non-food aerosols is finally leading to the development of many other pressurized foods.

Special public health precautions must be taken, including sanitary design of equipment, temperature controls, aseptic gassing, mechanical valve insertion, and sanitizing of valve and can.

The consumer is convenience-package-minded, but the industry must not neglect to continuously follow basic public health requirements for these new products.

At a recent meeting of manufacturers and suppliers for the pressurized packaging field, a manufacturer of pressurized foods issued the following warning:

"... The custom filler *must* provide complete services along with active sales campaigns to demonstrate to merchandising food people the facts and potential of this field. He must have the facilities and personnel to perform and a willingness to cooperate with suppliers and food companies alike, for the problems can easily be too vast for one to handle. He must be prepared to meet high production demands on short notice with positive and unwavering quality control. Costs must likewise be carefully controlled to avoid pricing above the volume market (2)."

It was further pointed out that bacteriological control was important and descriptive tests for the final product were given, but no mention was made of the need for the application of sanitation procedures and the importance of using equipment designed for sanitation.

The sanitarian is familiar with pressurized whipped cream and its phenominal growth to over 80 million cans in 1958. It has been the forerunner in the convenience packages that are steadily becoming an important part of the food industry. The list of products capable of being marketed in the pressurized package continues to grow. Available today are milk and milk products, cream, dairy dressings, horseradish whip, barbecue sauce, catsup, coffee, chocolate and other syrups, tea, toppings, batter, cheeses, sweeteners, butter, and mustard.

This is only a partial list and food technologists are rapidly developing new products. Many of them have one common feature. They are capable of supporting microbiological organisms. This is why the sanitarian must play a vital role in the metamorphosis of pressurized foods. No attempt will be made in this discussion to delve into the technological problems that beset the industry, other than in their relation to public health.

Pressurized foods properly prepared can be a boon to the restaurant sanitation program. Their very nature makes them single service and some day may eliminate the insanitary cream pitcher, the open sugar bowl, the unsightly mustard and catsup container, the open and unrefrigerated bowls of salad dressings, the finger print on a butter patty, and the mold-coated syrup containers.

A short review of the processing problems and techniques will serve to introduce the role the sanitarian must play in this field.

There are a number of reasons, each in itself contributing a small but significant part, why pressurized foods have taken so long to reach the consumer. Some of these are:

1. The slow speeds of the present whipped cream fillers.

2. The reluctance on the part of governmental officials to approve certain of the newer gases for food products.

3. The need for more basic research into formulae and types of food to be pressurized.

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4. The absence of proper valves for dispensing foods other than the foamed type.

5. A dearth of sanitary plants for the packaging of pressurized products.

6. The lack of equipment engineered for sanitation.

Although present whipped cream fillers range in speed from 40 to 60 per minute, there are available machines that will fill 200 per minute, and it has been estimated that within the next few years, these speeds will be increased to 300 per minute. The speeds, of course, are a direct function of the type of gas and the method of gassing used.

Where nitrous oxide and carbon dioxide are used, as in the case of whipped cream, it is necessary to agitate the final container after it has been sealed and gassed, in order to fully incorporate the gas into the product. This, of necessity, retards production. Although machines could be manufactured that would fill at high speeds and feed a series of shakers, it is economically unsound, not only from a cost standpoint, but from space limitations to build such equipment. The answer, of course, is to find a gas or gases that could be incorporated into the food product in the same manner and at the same speed that gases are incorporated into non-food products, thus eliminating shaking. It will also be necessary to vary valve design in order to feed the containers in an automatic manner and thus eliminate the languid and insanitary hand-operated procedures now in vogue.

The fillers, the valves, the gases, and the entire assemblies have been developed to increase capacity. What then is the next step in bringing this product to the consumer? Are there gases other than nitrous oxide and carbon dioxide that could be used in the food industry?

It is surprising how many gases are available for this purpose – nitrogen, argon, hydrogen, and certain fluorinated hydrocarbons. The first three gases mentioned are all non-liquefiable at the temperature and pressure ranges commonly used in pressure containers, and vary in solubility. The propellant force is provided mainly by expansion of gas in the head space of the can and, to a limited extent, by expansion of dissolved gas in the product (*1*). With compressed gas propellants, dispensing pressures decrease as the product is used and the head space volume becomes greater. By contrast, the liquefied gas propellants (halocarbons and hydrocarbons) used for most non-food pressurized containers, provide a uniform dispensing pressure for the entire contents of the container. The liquefied gas partially mixes with the product and the gas vapor fills the can head space above the product-propellant mixture. When the container valve is actuated, pressure on the head space forces the mixture up a siphon tube and through the valve opening. As soon as the mixture contacts the atmosphere, the propellant expands and vaporizes, scattering the product into small particles.

The most significant step would be the introduction of a liquefied gas propellant into the food field. Experimentally, food packs with a fluorinated hydrocarbon propellant have been made by a number of larger companies.

Regular fluorinated hydrocarbon propellants are not suitable for use with foods because of their taste. In addition, there is a possibility that a breakdown could occur during storage that would result in the formation of free fluoride ions. A new type of liquefied gas, octafluorocyclobutane (Freon C-318) has been developed for this purpose (*4, 9*).

At the request of the Food and Drug Administration, a long term toxicological study was conducted. The study has been completed and is presently undergoing evaluation by the Food and Drug Administration. Those in charge of the study have reported, "Our experience to date indicates that C-318 should present no problems from a toxicological standpoint."

This gas is practically odorless and tasteless, – a very important factor for that segment of the food industry which is interested in producing bland foods. Furthermore, the experimental products made, using the gas, indicate that it will not likely promote can corrosion or spoil product flavor. With soluble oil base foods, the use of C-318 may be economically feasible. Even where acid and alkaline foods have been used, laboratory tests have shown no deterioration under rigorous storage conditions.

C-318 has still another valuable contribution to make. It can be cold filled. In other words, the product to be pressurized is placed in a container and the fluorinated hydrocarbon then added in the liquid state at approximately -30°F. The container is then capped and sealed. When the contents of the container reach room temperature, the liquefied fluorinated hydrocarbon has become a gas, ready to dispense the product.

Of the presently acceptable compressed gases, nitrous oxide and carbon dioxide have had the widest use, both as foams and as sprays. Both gases are readily soluble in water, fats, and oils. When a product, such as cream, is discharged from the can, the dissolved gas expands into tiny bubbles, releasing in a whipped foam.

Nitrous oxide has a slight sweet taste, which is not detectable in most foods. Carbon dioxide imparts a more acidic taste, which is objectionable in bland foods. This is why certain of the whipped creams and toppings have used a mixture of these two gases.

One of the most promising versatile compressed gas propellants is nitrogen (*8*). It is inexpensive, chemically inert, has no taste or odor, and has very little effect on food colors. Since it is relatively insoluble, nitrogen does not change the physical appearance of most foods. It dispenses both thin liquids and thick pastes in their original state when used in combination with special actuator valves. Nitrogen is best for products which are to be delivered in a non-aerated continuous stream with a minimum amount of foaming or bubbles. It will not burn or explode.

When nitrogen was originally discovered in 1772 by Rutherford, it was thought that it did not support life. Present day research, however, has indicated that in the presence of oxygen, nitrogen will not inhibit mold growth (*6*). The practical elimination of oxygen from pressurized containers is, commercially unfeasible, so that other methods have to be developed for insuring ultimate sanitation rather than by gassing alone.

However, before methods of processing or handling can be described, it is of primary importance that limitations and needs for formulae be understood (*5*). Experience to date has indicated that it is almost impossible to take an existing formula for a food product and subject it to pressurizing without significant changes. Many of the food products now on the market are of such high viscosity that they could not normally be dispensed through existing valves. With products that have large particles, or are pulpy, it will be necessary to reduce the particle size to a point wherein proper flow through the valve orifices can be achieved.

Another important factor is pH. This can affect not only the final shelf life, but can also be of considerable importance in its effect upon the container liner. Color and flavor must also be given consideration in the formulation of a food product for pressurizing, in order to obtain the desired dispensing characteristics.

On the basis of valves now in existence, a particle size of less than 1 mm. is required to prevent clogging. One manufacturer states that the largest particle size permissible should be no more than 60% of the diameter of the smallest orifice. The presence of large particles will not only cause a change in the pattern of dispensing, but may also result in complete clogging.

The control of viscosity must be given careful consideration. It is viscosity that will limit many existing formulations from being pressurized. However, reformulation can easily correct this deficiency by homogenization or by the use of additives.

High acid, low soluble solids, with a pH under 4.1, are acceptable. Low acid, low soluble solid foods, such as dairy products, with a pH ranging from 4.5 to 7.0, also have been successfully packaged. However, the pH will have to be tailored for the particular product.

Foods can be propelled in four ways – as a foam, a spray, a steady stream, or a drop. In all cases, the valve guides the product and actuates the propellant. The type of valve and actuator used are extremely important. The design of the valve mechanism, the can, and the dip tube, if necessary, will have an important bearing upon the final product.

There are two basic types of valves. Foam valves are best known in the food industry, since they have been used for a number of years for whipped cream. Recent research has indicated that this valve, under certain circumstances, can also be used in a stream delivery. In using this valve, the can must be inverted and the valve dispensed in that position. This, to a certain extent, limits its functions.

The other type has a dip tube extended from that portion of the valve that is inside the container, to the bottom of the can. In this case, products can be dispensed in the upright position and can be used for solid streams, sprays, foams, or drops. It differs further from the foam valve in that its small orifice limits particle size, as well as viscosity.

With the use of certain foods in either type of valve, there may be a tendency for the food to deposit upon the dispensing spout after use. This can build up into a plug which will in turn restrict or completely stop the flow and increase bacterial growth. This again points up the need for proper product formulation together with sufficient shelf life testing and the inclusion of a program of sanitation.

The type of can in use has changed considerably over the last few years. It is available in sizes from fractions of an ounce up to 16 ounces, and is normally coated with a protective material to prevent corrosion. This corrosion is not only due to the food itself, but to the head space and the incorporation of oxygen. There are certain foods, particularly those high in acid, which would deteriorate in a can of this type. For this purpose, an aluminum container has been developed and is now undergoing market tests in several areas. The cost factor is the greatest hindrance in the production of the aluminum can. However, it is possible that increased consumption will tend to reduce the price differential.

Although processing is similar to that used in the canning industry, there are certain inherent differences that must be given attention in order to prevent spoilage and increase shelf life.

Where the final product is to be refrigerated, precautions similar to those taken in the manufacture of whipped cream, should be observed. The products can be pasteurized at relatively high temperatures through properly sanitized equipment into clean containers. Extreme care must be taken to avoid contamination during the valving or gassing procedure. Furthermore, the equipment used for filling, gassing, and capping, must meet equipment sanitation requirements, similar to those developed for the 3A Standards.

Where pressurized foods are to be stored for long periods of time without refrigeration, precautions must be taken throughout the processing and filling cycles to preclude the entrance of both food spoilage and food poisoning organisms. Normally, canned foods are not processed to obtain absolute sterility, but to destroy those organisms which could prove harmful upon ingestion, and those organisms which could cause spoilage when cans are held unopened under normal storage conditions.

All processing procedures, handling methods, and many of the packaging requirements and product composition specifications have, as their basis, the need for preventing or inhibiting microbiological spoilage.

Since the gases used in pressurized foods have little or no inhibitory effect upon the growth of food spoilage and pathogenic organisms, the same sanitation techniques now practiced in the dairy and food industries for conventional packing of foods, would have to be followed.

Products that are high in acid, or that are high in sugar, should be filled and gassed hot (170°F. to 190°F.) in order to prevent spoilage. It is possible to gas a product with nitrogen at 190°F., producing maximum can pressures of not over 120 pounds without any danger involved.

Low acid foods must either be refrigerated or processed at relatively high temperatures to prevent spoilage. Where dairy products are used, as an example, filling should be done into sterile containers after the product has been properly pasteurized. It is highly important that all necessary precautions be taken to prevent contamination from the point where the products leave the pasteurizer until the final container is gassed and sealed.

One manufacturer has successfully produced a sterile whipped cream product, using an aseptic canning system.

Unrefrigerated low acid foods must also be processed at relatively high temperatures. In the food industry today, ultra high temperature equipment is available that can handle food products at temperatures up to 290°F. Here, the importance of aseptic handling is quite evident, and undoubtedly aseptic filling and canning techniques will be required before such food can be packed commercially.

Where the temperatures of processing are not critical, it is possible to first process the foods into clean containers, gas, and crimp, and then subject the gassed products to retorting at temperatures of about 190°F. The advantage of this method of processing is that "commercial sterility" can be obtained in the final package, although some contamination may occur during the processing cycle.

At one time, it was considered dangerous to process containers that had already been gassed. Twelve-ounce aerosol cans have been charged with nitrogen and processed for 30 minutes at 240°F. without any abnormal conditions arising, either relating to the product itself, or to the container.

Where the filled container is processed either before or after gassing, precautions must be taken that the valve and the dip tube, if used, be made of plastic materials that are capable of withstanding these high temperatures without any change in dimension or strength (3). The only material at present that has been successful for this purpose is nylon, although it is possible that other plastics, such as polypropylene and polystyrene, can be altered to be sufficiently heat-resistant.

Regardless of the method of processing, filling, or gassing that is used, the need for following basic public health requirements must be continuously emphasized:

1. The processing equipment must be of sanitary design.
2. Proper controls must be included to insure that the temperatures required are consistently obtained.
3. The filling equipment cannot be of the type normally used for non-food pressurized packages. All the essentials of a sanitary filler must be included in this equipment.
4. Gassing must be done under aseptic conditions. This includes the storage of the container and the handling of the gas, whether it be in the liquid or vapor state. Contrary to some conceptions, nitrogen will not prevent the growth of microbiological organisms.
5. Valves should be inserted mechanically and should either be received in a sterile condition or sterilized before use.
6. The plant in which the foods are pressure packaged must be of sanitary construction and operated in such a manner as to minimize contamination from any source.

Today, there is a movement on hand for the establishment of so-called "contract packagers" to do this job. These, in general, are manufacturers who have been packaging non-food materials, such as insecticides, hair sprays, paints, and waxes. Their plants are not physically suited to handle food products. Their lack of knowledge of santiary procedures and the importance of quality control could lead to serious food-borne outbreaks. The results might not only be harmful to the consumer, but could also result in a deluge of governmental prohibitions and regulations that would seriously retard the sale of pressurized foods.

The food industry should proceed cautiously in the pressurized food field. There is available inexpensive laboratory equipment which includes all of the necessary components for gassing, crimping, and sealing the containers. This can help many plants to test their own products, determine what changes have to be made in their formulation, and permit them to conduct small market tests before installing complete filling lines. At the same time, the sanitation problems can be investigated and many public health pitfalls eliminated.

It is up to the sanitarian to insure that the food products sold in pressurized containers are safe and that all of the sanitation procedures now required in the food and dairy industry are incorporated into the manufacturing and storage processes. It is shameful to report that sanitarians today are neglecting to apply the principles that have been developed for other foods. The equipment and the know how are available, but as long as enforcement is lacking, the products will continue to be handled, processed, and stored under insanitary methods.

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