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ASEPTIC PROCESSING OF FOODS CONTAINING PARTICULATES

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SUMMARY

Aseptic processing involves sterilising the product and package separately, and filling under sterile conditions. Advantages include better product quality compared with canned products, lower transport and storage costs compared with frozen products, and virtually no restriction on package size. Problems include ensuring adequate heat penetration into the particles to ensure sterility, preventing separation of particles from the carrier liquid, and retention of particle structure and shape. Particulate foods can be sterilised in scraped - surface heat exchangers. Other methods involve heating the particles separately, and combining them during filling. Projects will commence at the International Food Institute of Queensland (IFIQ) on aseptic packaging of a meat and vegetable product, and aseptically packaged mango pieces.

INTRODUCTION

Aseptic processing involves sterilising the product and package separately, and filling under sterile conditions. This is in contrast to conventional canning, where the product is sterilised in the can. Pflug *et al.* (1990) have defined aseptic processing as "the shorthand name for the food production system where product moves in continuous flow through a heat-hold-cool thermal process and is then filled into a sterile package. The package is sterilised, filled, and sealed in a sterile environment".

Aseptic processing of particulate foods presents special heat transfer and quality retention problems. This paper aims to review the advantages, problems, and technology of aseptically processing foods containing particulates.

ADVANTAGES

(a) Improved product quality (reduced loss of flavours, aromas, natural colours or volatiles);
(b) Energy savings;
(c) Consumer convenience;
(d) New marketing opportunities; and
(e) Bulk packaging (Wernimont 1983; Anon 1988) .

Some companies are producing aseptically processed low-acid foods containing particulates packaged in semi-rigid containers. As more experience is gained with the process, foods containing larger particulates such as beef stew, spaghetti, ravioli, chilli and chinese meat and vegetables will become available (Anon 1988). Aseptic low acid products of the future are likely to be products that are now frozen or canned (Hannigan 1983) and demand for such products is likely to increase over the forthcoming decade as more consumers look to convenient and high quality products in alternative (cheaper) forms of packaging (Murray 1985).

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PROBLEMS

Heldman (1989) has highlighted critical factors affecting aseptic processing of foods containing particulates. Factors affecting heat transfer are the particle size, shape, thermal properties of the particle (thermal conductivity and specific heat) and the thermal properties of the carrier liquid (surface or convective heat transfer coefficient). There are also various factors affecting the residence time of particles in the heat exchanger and holding tubes. These are the particle size distribution, the carrier liquid flow profile, the type of heat-exchanger used, and the configuration of the holding tubes (length and number of bends).

Sastry *et al.* (1987) have considered microbiological problems in continuous sterilisation of low acid (pH > 4.6) foods containing particulates. The product, including particle interiors, must receive a heat process adequate to inactivate spores of *Clostridium botulinum*. There is no reliable method to measure the internal temperature of particles flowing through a heat exchanger.

An alternative way of determining the lethality of the heat sterilisation process, is to inoculate the particles with heat resistant bacterial spores before processing, and test for sterility after processing. A method of immobilising bacterial spores in calcium alginate gel has been described by Dallyn *et al.* (1977), who used *Bacillus stearothermophilus* as the test organism. The gel was formed into beads containing randomly distributed spores. The organism had high heat resistance, and the beads were robust enough to withstand passage through a scraped surface heat exchanger at temperatures up to 140°C.

Sastry *et al.* (1988) considered that a suitable bioindicator should be in the form of a particle, possessing at least the following necessary and/or desirable characteristics: (1) large size (about 2.5 cm), containing immobilised bacterial spores throughout the interior, and especially at the slowest heating zones; (2) geometry, thermal properties and responses similar to real food particles; (3) visual distinguishability from real particles, permitting easy recovery from processed product; (4) retention of spores without leakage through all process steps; (5) shelf-stability, permitting easy constitution and whenever desired (this is more a desirable, rather than necessary characteristic); and (6) physical durability, possessing the ability to withstand process stresses without disintegration.

According to Murray (1985) the widespread development of particulate thermal processing has been limited by a number of constraints.

These include:

(a) the different penetration rates for different particulates and for the carrier liquid phase. Therefore the liquid phase is often overprocessed;

(b) the possibility that although harmful microorganisms are destroyed, enzymes will survive that can be detrimental to the product;

(c) the fragile nature of particulate products once heat treated, and the difficultly in transporting such products without damage;

(d) the possible separation of particulate and liquid phases either during processing or in storage prior to packaging.

The difficulties outlined in (d) could be overcome by processing the particulates in a liquid of high viscosity than the desired end product and blending back with a diluent at the filling stage. The difficulties outlined in (a) could be overcome by processing the solid and liquid phases separately.

(a) Scraped - surface heat exchangers

Scraped surface heat exchangers will continuously process products that -

1. Are very heat sensitive
2. Form film on the heat exchange surface
3. Are highly viscous or become highly viscous during processing; or
4. Have a particle size or delicacy that can not be accommodated by other heat exchangers. Products containing up to 40% particulate content, and particle sizes up to 20 mm can be handled. (Anon 1989)

Therefore scraped surface heat exchangers can effectively handle any products presently batch processed in kettles or tanks and can be pumped. The scope of application applies to heating, cooking, cooling, freezing or aseptics. Areas within the food industry where scraped surface heat exchanger technology can be used include gravies and slurries, ground meats, soups and stews, stroganoff, paté, meat and fish spreads, pet food fruit purees and pulps and dairy products (Day 1970; Volan and Ziemba 1970; Hall 1972, Hannigan 1983; Anon 1989). Applications include heating to either increase shelf life or achieve sterilisation.

Information on processing conditions is scant. Generally products are preheated to approximately 50°C before pumping through the scraped surface heat exchanger where the product is heated to 143-149°C. Holding times vary between 30-45 s (Volan and Ziemba 1970; Wagner 1984). However Murray (1985) states that the optimum process is based on a processing temperature of approximately 130°C. This requires a sterilising time of approximately 5 min for a 20 mm particulate.

(b) Other Processing Systems

Fellows (1988), and Hersom and Short (1981) have described the "Jupiter Process" which uses a double cone heat exchanger. Solid pieces of food are fed into the double-cone vessel, which is then rotated slowly on a horizontal axis. Steam is introduced and the product is tumbled through the steam. Liquor is added during sterilisation to prevent damage to the solids by the tumbling action. After sterilisation the product is rapidly cooled with cold water and sterile air, and the condensate-water-stock is removed. The liquid portion of the product is sterilised separately in a plate or tubular system and added to the solids.

Another system, still in the developmental stage, is ohmic heating. In ohmic heating a conducting fluid is heated directly by electrical energy. An alternating current is passed from electrodes, through the fluid which is contained in a non-conducting pipe. There is sufficient resistance in the fluid for energy losses to occur, and the fluid heats evenly. Conversion efficiencies from electrical energy to heat of greater than 90% are claimed, and particulate feeds may be processed without shearing forces associated with some other types of heat exchangers. With this system, the sterilising effect is greater than the cooking effect, so delicate products can be processed and still maintain integrity (Anon 1990; Halden *et al.* 1990).

Another system, the "Stork Steripart" system (Anon 1989), allows liquor and particulate fractions to receive different heat treatments. The liquid fraction can flow at a high velocity and is subjected to a heat treatment comparable to that of a UHT process. The particulates, which may vary in thermal size, can be held in the main flow during preset times and are subjected to a heat treatment suited to their relevant size.

(c) Packaging

Various types of aseptic packaging fillers are available, which can handle particulate materials. These include the "Intasept" filler which packs in laminate bags and the "Combibloc" filler, which packs in laminate cartons.

Foil laminates used for bulk catering service packs are sterilised by gamma irradiation and the food contact surface cannot be contaminated prior to filling. However plastic thermoformed trays for use in retail packs would require sterilisation immediately prior to filling. Bockelmann (1985) found that extruded plastic products had microbial counts ranging from 0.3 to 10 microorganisms per 100 cm^2. On paper based laminates loads ranged from 2 to 5 microorganisms per 100 cm^2. Superheated or saturated steam could be used for sterilisation of packaging materials and has been applied for the sterilisation of polystyrene cups.

QUALITY CONSIDERATIONS

In conventional thermal processing, such as canning, heat has to penetrate to the centre of the can (the "cold" spot) to sterilise the product. This heat has to be removed after processing. Low acid foods, such as meat and vegetables, require quite a severe heat process to ensure sterility, which can have some adverse effects on quality. These effects are reduced in aseptic processing (Fellows 1988). Colour, flavour, and texture are better retained than in a canned product. Nutritional losses are also lower in aseptic processing.

Barnes (1990) reported 82% thiamine retention in aseptically packaged chicken soya, compared to 27% in the canned product. She also found 91% retention of ascorbic acid in aseptically packaged tomato soup, compared to 59% after conventional processing.

During storage, various changes occur including oxidative darkening, rancidity, and gradual nutrient losses. The rate of change will be affected by storage temperature, packaging material, and pack size. An advantage of aseptic processing is that bulk packaging is feasible. This means a high ratio of product to package surface area, and potentially decreased rate of changes during storage.

ASEPTIC PROCESSING RESEARCH AT IFIQ

Research on aseptic processing at the International Food Institute of Queensland (IFIQ) has been carried out on aseptically packaged mango and passionfruit puree products. The purees were sterilised in a scraped surface heat exchanger, cooled in a tubular heat exchanger, and packaged with an "Intasept" filler into laminate bags (Isaacs 1990). Funding applications have been made to the Horticultural Research and Development Corporation and the Committee of Direction of Fruit Marketing for a project to develop aseptically packaged mango particulate products (e.g. pieces, slices). The research will investigate factors such as particulate size, ratio of particulates to carrier liquid, heat times/temperature, and storage stability.

Another new project, funded by the Australian Meat and Livestock Research and Development Corporation, is aimed at developing aseptically packaged meat and vegetable particulate products. This work is being carried out by IFIQ, and a commercial partner. The research involves development of suitable formulations, establishment of processing conditions, evaluation of packaging alternatives, and storage stability trials. The aseptically packaged product quality will also be compared against canned, retort-pouched, frozen, and chilled products.

REFERENCES

Anon (1986). *Food Eng.* 58:90.

Anon (1988). *Food Technol. N.Z.* 23:16.

Anon (1989). *Food Proc. June:*41.

Anon (1990). *Food Technol. N.Z.* 25:21

Barnes, J. (1990). Nutrition Paper in "Marketing - the Competitive Edge for the Food Industry", QDPI Seminar, Brisbane, 14/11/90.

Bockelmann, B., von. (1985). General aspects on aseptic packaging in flexible containers. Proceedings IUFOST Symposium on Aseptic Processing and Packaging of Foods, Tylosesand, Sweden, p196-202.

Dallyn, H., Falloon, W.C. and Bean, P.G. (1977). *Lab. Prac. Oct:*773.

Day, R.H. (1970). *Food Trade Rev.* 40:33.

Fellows, P. (1988). Food Processing Technology: Principles and Practice. Ellis Horwood, U.K. 242-246.

Halden, K., De Alwis, A.A.P. and Fryer, P.J. (1990). *Int. J. Food Sci. Technol.* 25:9

Hall, C.E. (1972). *Aust. Food Man.* 41:14.

Hannigan, K. (1983) *Food Eng.* 55:85.

Heldman, D.R. (1989). *Food Technol.* 43:122.

Hersom, A.C. and Shore, D.T. (1981) *Food Technol.* 35:53.

Isaacs, A.R. (1990). Aseptic packaging of tropical fruit purees. Australian Institute of Food Science and Technology, "Food Pacific" Convention papers. Brisbane, Queensland. 216-220.

Mans, J. (1988). *Prep. Foods* 158:95.

Murray, S.A. (1985). Thermal processing of particulate containing liquid foods. Proceedings IUFOST Symposium on Aseptic Processing and Packaging of Foods, Tyloesand, Sweden, p81-99.

Pflug, I.J., Berry, M.R. and Dignan, U.M. (1990). *J. Food Prot.* 53:312.

Rogers, S. (1990). Production of aseptic meat products using scraped-surface heat exchanger technology, QDPI report.

Sastry, S.K., Li, S.F., Patel, P., Konana Yakam, M., Bafna, P., Doores, S. and Beelman, R.B. (1988). *J. Food Sci.* 53:1528.

Sastry, S.K. and Zuritz, C.A. (1987). *J. Food Proc. Eng.* 10:27.

Tuley, L. (1988). *Food Man.* 63:47.

Volan, R. and Ziemba, J.V. (1970). *Food Eng.* 42:94.

Wagner, J.N. (1984). *Food Eng.* 56:106

Wernimont, D. (1983) *Food Eng.* 55:87.