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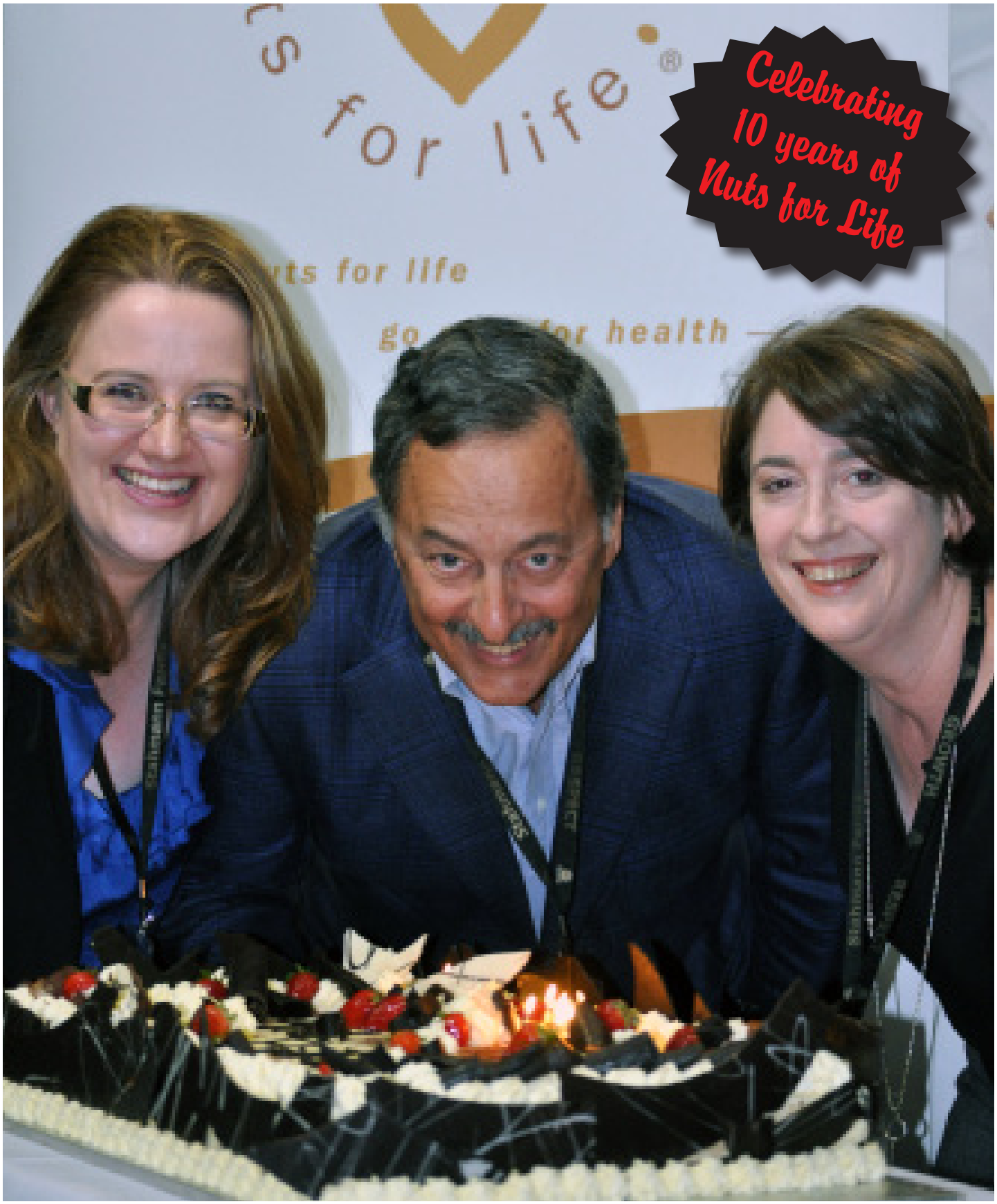

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Nut pasteurization:
minimising impact on appearance, colour and flavour

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Abstract

Following food-borne illness outbreaks and several major product recalls linked to nuts, these low moisture foods are now increasingly viewed as high risk products. Although microorganisms cannot develop, research has shown that pathogens including Salmonella, survive well on nuts and may cause severe illness. To mitigate this risk, nut processors are increasingly applying a pasteurization step to eliminate the pathogens and reduce the microbial load in their products.

A new thermal process applies dry saturated steam in a pressurized vessel showing superior pasteurization capabilities while preserving the raw attributes of the nuts. Pasteurization can be achieved in a partial vacuum where saturated steam temperatures are lower thus protecting the characteristics of the product. This batch process is available in a modular range of sizes and throughputs from 150kg/h to 12'000kg/h.

Contamination issues in nuts

Around the world peanuts, almonds, pistachios, pecans, pine nuts, macadamias, hazelnuts, Brazil nuts, and walnuts have all been involved in product recalls due to salmonella or *E. Coli*. These have prompted food safety authorities to assess their microbiological safety. As a consequence, major changes in food safety management are taking place, to ensure continued consumer confidence in the health benefits of nuts, and to protect the brands and reputation of companies in the industry.

Low moisture foods have been, until recently, considered safe because they do not support the growth of microorganisms. Research conducted on almonds, has shown that Salmonella is a bacteria of particular concern because it can be pathogenic at low doses and can survive in adverse conditions for a long time. The young, the elderly, and those with weakened immune systems are most at risk from exposure to Salmonella which may require hospitalization and even result in fatalities.

Industry reliance on sampling and testing is inadequate because Salmonella may be present in very low doses. In addition it is difficult to detect Salmonella because it is unevenly distributed in the product. Following two food borne illness outbreaks linked to the consumption of almonds, the Almond Board of California (ABC) conducted a risk assessment. This showed that the consumption of raw almonds carried a 78% risk of one or more cases of salmonellosis per year. This risk could be reduced via pasteurisation to <1% with a 5 $\log^{10}$ reduction process (100'000 fold reduction) in Salmonella. Subsequently the almond Board of California determined that a 4 $\log^{10}$ reduction would provide the consumer with adequate protection.

In 2007 the ABC decided to mandate the pasteurization of all almonds sold in North America. As a consequence almond processors were required to have their equipment validated for a 4 $\log^{10}$ kill performance, or have their product treated by an approved third party. In the USA fumigation with Propylene oxide is most widely used but its use is limited for exports. Natural pasteurization technologies based on steam and in particular, new dry saturated steam processes are gaining favour.

Since the pasteurisation mandate in 2007, almonds have been the only nut in the North American market that has not been subject to a product recall.

Thermal processes

Microorganisms are killed by heat which is the basic process behind pasteurization, a natural process

Figure 1. Photograph of loading a 1400lb container of walnuts in the autoclave. This pasteurization unit will hold 6 bins for a total volume of 8400lbs/batch. Total cycle time is 40 minutes including a short pasteurization phase.

that uses no chemicals and leaves no residues. Thermal processes include oil roasting, hot air roasting, blanching, or steam treatment. In a continuous thermal process the product is in movement on a belt, in a bath, or in a screw, and conditions are inherently non-homogenous. Steam is a more efficient heat transfer medium than dry heat but, at ambient pressure, a lot of moisture is added to the product and necessitates a drying step.

The batch pasteurising process in a pressurized chamber creates dry saturate steam which is much more effective than ambient steam. It also allows treatment of nuts at lower temperatures, thus protecting their natural raw qualities, and does not require a drying step. The product is placed in an autoclave in which a deep vacuum is first established to remove all the air. When the steam is introduced in the autoclave, it fills the vacuum and reaches the product raising its temperature homogeneously. In the autoclave, pressure and temperature can be precisely controlled to work in dry saturated steam conditions. In this way lower temperatures can be applied for a short treatment time, thus minimizing the impact on the nut and moisture transfer to the product.

The dry saturated steam process is many times more effective than other thermal processes because the latent heat stored in the steam once transferred to the surface of the treated product, eliminates all contaminants. The universality of the physics of the process can be applied to large and small autoclaves and can be scaled up for processing large batches.

Not all nuts are created equal

Nuts are a group of products with very different characteristics. Moisture, heat and vacuum affect each one differently and require a specific treatment profile. In addition, the thermal resistance of the contaminant is not the same on different nuts and testing and validation is required for each of them. The optimisation of the pasteruisation process for a specific nut should take into consideration the log reduction suitable to address the risk level for that nut, while minimising the impact of the process. The process can be optimised for whole nuts as well as nut pieces and nut meal.

Control sample

Pasteurized sample

Figure 2. Photograph of almond samples showing that the pasteurized process did not produce any skin lifting.
(Photo courtesy of Napasol AG)

Validation of the process requires conducting a biological challenge test to establish suitable parameters to reach the log reduction targeted. The nuts are artificially inoculated with high levels of bacteria, usually *Enterococcus faecium* which is a non-pathogenic Salmonella surrogate. The samples are then placed in the load to be pasteurized. Two key parameters are determined: the time and the temperature needed to achieve the target kill rate. These parameters will be different for each nut.

A typical problem for almonds treated with steam is skin lifting and subsequent flaking which exposes peeled surfaces of the nut. To avoid this phenomenon, almonds require a specific steam injection profile that allows the meat of the nut and the skin to expand at the same time.

Walnuts, with their high oil content, are sensitive to high temperatures which affects their colour. Microbiological reduction performance criteria have to be reached with lower pasteurization temperatures. An added benefit of the process is that pasteurization has a beneficial effect on the shelf life of walnuts. Because of their high oil content they are particularly susceptible to rancidity and this low temperature treatment protects the nut. The process reduces peroxidase levels by 20%, a difference that is maintained over time as shown in the shelf life study below.

A common issue with some steam treatments is moisture pickup and

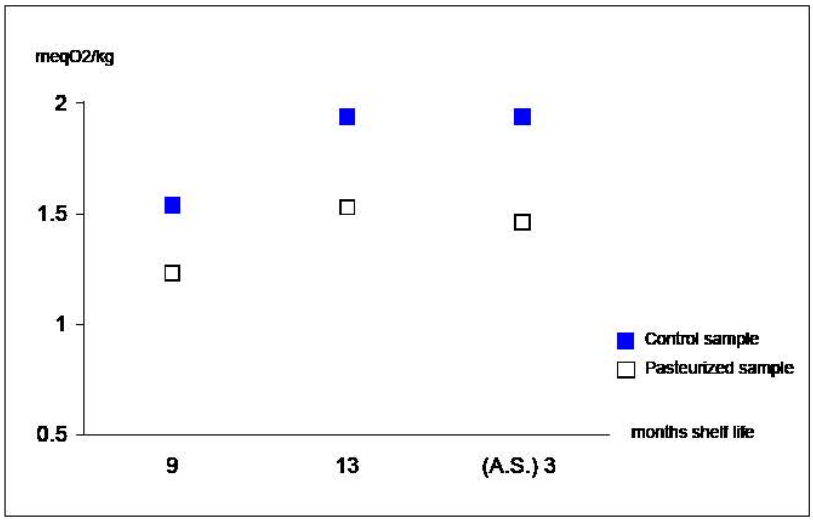

Figure 3. Shelf life study of peroxide values in pasteurized walnuts. Plot of peroxide values at 9 months and 13 months storage, and in accelerated shelf life conditions in a climatic chamber for 3 months at 30°C and 90% humidity (A.S. 3 months). Values are 20% lower in the pasteurized samples at 9 months and increases to 24% in samples subjected to accelerated shelf life conditions.
(Figure courtesy of Napasol AG)

loss of texture which is avoided by the short treatment cycle of the dry saturated steam process.

The dry saturated steam process offers a solution for the decontamination of nuts while preserving their natural appearance, colour, and flavour. Some nuts are unaffected by higher pasteurization temperatures while others need a lower temperature and/or longer treatment time to reach target microbial reduction. Others still require the flexibility of the technology to ramp up in temperature slowly to avoid skin lifting (almonds, peanuts), or control the final vacuum phase to avoid fats leaching from the nuts (pine nuts, macadamias).

More effective latent heat transfer, precise control of temperature, no drying step, homogeneous treatment, flexibility, and programs specific to each nut are key features of dry saturated steam technology. Pasteurization autoclaves are modular, compact units designed to be integrated in the product flow of nut processing facilities.

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