

Killing bacteria with superheated steam

For feed- and food manufacturers, drying in superheated steam (SHS) can offer several advantages as compared to hot air drying. Energy savings, eliminated risk of dust explosions, reduced fat oxidation and improved odour control are examples. SHS also has the potential to kill microorganisms more efficiently than other drying gases and is therefore very interesting in relation to food safety.

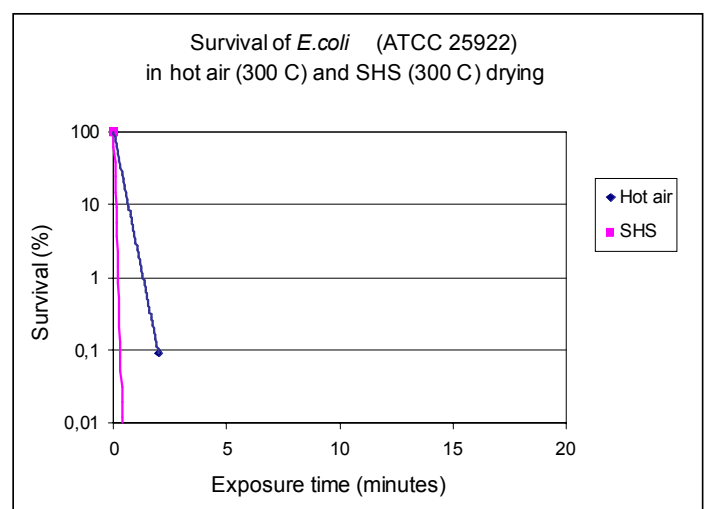
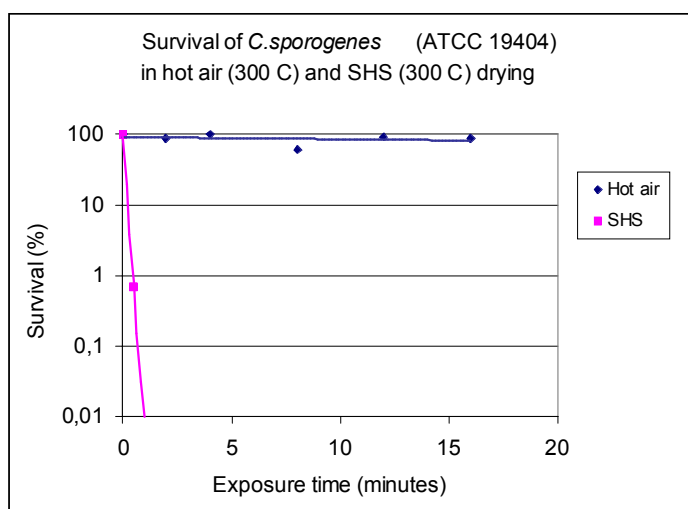
SHS is water vapour heated to a temperature above saturation temperature. When used as a drying gas, water will evaporate from the product and mix with the superheated steam. Until now, the drying method has found limited use for

heat sensitive products because elevated product temperature can cause damage to proteins. Nofima recently demonstrated that protein quality is maintained at short drying times and can now document a very good effect on hygiene. The drying method has therefore attained new actuality within the feed and food industry.

It is well known that the potential of heat to kill bacteria increases at high moisture levels. In order to obtain efficient heat kill in a drying process, the product should be exposed to a high temperature while the water content is still high. In hot air drying the temperature in moist product will not exceed 60-70 °C, while in SHS it will attain the saturation temperature of the drying gas, i.e. 100 °C at the pressure of 1 atmosphere. Hence, the killing potential of SHS is bigger than air at the same temperature.

Nofima Ingrediens has carried out a series of experiments where moistened protein powder was dried in SHS (300°C) and hot air (300 °C). To the powder was added a spore suspension of *Clostridium sporogenes*, a harmless bacterium with heat resistance similar to the food poisoning bacterium *Clostridium perfringens*. The common enteric bacterium *Escherichia coli* was used as a surrogate for *Salmonella*. SHS killed more than 99 % of the heat resistant spores in less than 0.5 minutes, while hot air at the same temperature had negligible effect. The less resistant bacterium *E.coli* was rapidly killed in both drying gases.

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Survival of *Clostridium sporogenes* (spores) and *Escherichia coli* during drying in hot air and superheated steam (SHS).