

ABSTRACTS OF PAPERS

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AGRICULTURAL AND INDUSTRIAL BACTERIOLOGY

1. Sorbic acid as a selective agent in cucumber fermentations. I. Effect of sorbic acid on microorganisms associated with cucumber fermentations.

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Cucumber fermentations in northern brining areas commonly have two groups of microorganisms active in them; viz., lactic acid bacteria and yeasts. The former group is desirable and the latter undesirable. Laboratory tests show that 0.1 per cent sorbic acid in an 8 per cent salt (NaCl) medium at pH 4.0 will completely inhibit the growth of the most common species of both subsurface and surface types of yeasts from these fermentations. Conversely, this agent was found to have no appreciable effect on the growth and acid production of the species of lactic acid bacteria common to cucumber fermentations even at a 0.1 per cent concentration. Both the pH and salt (NaCl) concentration were found to influence the effectiveness of sorbic acid as a yeast inhibitor. At pH 6.0 none of the major species were completely inhibited by 0.1 per cent sorbic acid, while all species of yeasts tested failed to grow in this concentration at pH 5.0. Four times more of the acid was required to prevent growth of two of the yeasts tested in a salt free medium than in an 8 per cent salt medium.

2. The influence of sorbic acid on microbial activity in commercial cucumber fermentations.

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This investigation was undertaken to determine the influence of sorbic acid on the fermentation of large-sized cucumbers brined under conditions typical of industry. Experimental lots (30 bushels each) with and without 0.1 per cent sorbic acid were brined according to the procedure of the operating pickle company (9.25 per cent salt mixed gradually to 15 per cent). In fermentations containing sorbic acid, populations of acid-form-

ing bacteria were reduced tenfold over controls; also, the developed brine acidity was only 0.2 per cent (calculated as lactic) as compared to 0.5 per cent in control lots. Microbial activity was markedly inhibited in experimental treatments using higher brine strengths (11.9 per cent and 15.8 per cent salt). Of the 92 cultures of acid-forming bacteria isolated, 51 were similar to *Pediococcus cerevisiae*, 23 resembled *Lactobacillus plantarum*, and 13 belonged to another species of *Lactobacillus*. The usual gaseous fermentation caused by brine yeasts was almost completely inhibited by the use of sorbic acid. Controls yielded populations of several hundred thousand per ml. of brine, while in lots containing sorbic acid, populations were less than 100 per ml. The principal species of yeasts found were the same as reported earlier from this laboratory. The inhibition of the gaseous fermentation was associated with a reduction of "bloater" (hollow stock) spoilage from 60 per cent in the controls to less than five per cent in sorbic acid lots. The sorbic acid brine-stock cucumbers were judged by a panel of pickle plant operators to be inferior in cure and color, and "not acceptable" or "barely acceptable" for commercial use.

A3. The influence of sorbic acid on the growth of certain species of yeasts, molds, and bacteria.

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Recent interest in the use of sorbic acid (hexadienoic acid) as a food preservative prompted the current study. Approximately 200 cultures, representing species in 35 genera of molds, 12 genera of yeasts, and 2 genera of acid-forming bacteria were tested for their ability to grow in liquid media containing sorbic acid. The pH of the culture medium was found to be the principal factor controlling the effectiveness of sorbic acid as an inhibitor for microbial growth. Most cultures grew well at pH 7.0 in media containing 0.1 per cent sorbic acid, whereas at pH 4.5 growth was usually absent. The organisms tested grew well in

control media at all pH values mentioned. Eight species of yeasts were tested for growth in broth containing sorbic acid (0.1 per cent) adjusted to eight pH levels between 4.0 and 6.9. All yeast species grew well at pH 6.0 and above; two (*Candida krusei* and *Torulasporea rosei*) grew at pH 5.4; and, none showed growth at pH 5.0 or below. The pathogenic species, *Candida albicans* and *Cryptococcus neoformans*, were unable to grow in 0.1 per cent of the chemical at pH 4.5. The inhibitory qualities of sorbic acid appear to be directly related to the concentration of undissociated acid. Seventy per cent of the sorbic acid is undissociated at pH 4.4 and at this pH there was little or no microbial growth as compared to controls. At pH 7.0, where inhibition was negligible to absent, less than 1 per cent of the chemical is in the undissociated form.

A4. *Site of microbial inhibition by sorbic acid.* GEORGE K. YORK, II and REESE H. VAUGHN*. Department of Food Technology, University of California, Davis.

The marked selective inhibition of catalase positive bacteria, molds, and yeasts by sorbic acid suggested that their oxidative metabolism was suppressed. Exploratory experiments eliminated the possibility of direct involvement of the catalase, cytochrome oxidase or glucose oxidase enzyme systems. Further studies with growing cultures, intact cell suspensions and crude and purified enzyme systems indicate that the principal inhibition by sorbic acid results from suppression of fumarate oxidation.

A5. *Special applications of the membrane filter in the food industry.* J. F. MURPHY* and J. H. SILLIKER. Research Laboratories, Swift & Company, Chicago.

A constant challenge to the food microbiologist is the development of simpler, rapid, and more accurate methods of analysis. The membrane filter technique, although not the ultimate analytical technique, has been found to have definite advantages over slower, relatively cumbersome standard methods. Our aim was to find and develop new applications for the membrane filter technique with special emphasis on its use in investigational and control studies in the meat industry. After a preliminary survey, three specific areas were found where the membrane filter technique could be used to an advantage: (1) A rapid (four hour minimum) analysis of process water; (2) A qualitative or quantitative determination of the numbers of bacteria on processing equipment; and (3) Non-destructive sampling of meats. In all three of the above mentioned instances, an adaptation of the membrane filter

technique was developed and found successful. A rapid bacterial count of process water was determined by staining a filter after four hours incubation and counting small colonies microscopically by using the oil immersion lens. Non-destructive sampling of meat and sampling of process equipment was accomplished by placing a nutrient-soaked filter on the surface to be sampled. For quantitative data, the filter was ground in dilution water and consequently handled according to standard agar plate count procedure. For more qualitative data the filter was incubated on a nutrient pad and after a suitable incubation procedure, growth density was noted. The results obtained using these procedures compared in accuracy with standard bacterial count determinations.

A6. *Inhibiting the growth of food poisoning bacteria in meringue-topped fruit cream pies.* A. G. CASTELLANI*, R. MAKOWSKI and W. B. BRADLEY. American Institute of Baking, Chicago.

Cream filled baked goods have sometimes been incriminated in food poisoning outbreaks. With the acid fruit cream pies, however, prevention of bacterial growth may be achieved by pH control without loss of acceptability. A pH of 4 was found to prevent staphylococcal growth in untopped pineapple cream filling incubated at 37°C for 6 hours. However when topped with a bacteriostatic meringue (50 per cent glucose, pH 7), prolific growth occurred at the interface between the filling and the meringue, i.e., a thickness of about 1 mm. of meringue and 2-3 mm. of filling and some growth appeared to occur also throughout the filling. At pH 3.5 no staphylococcal growth occurred in the filling when incubated at 37°C but counts between 2,000,000-20,000,000/g. were found at the interface. Upon incubation at 37°C no growth occurred at the interface. With a filling at pH 3.8, a bactericidal effect was noted against *Salmonella meleagridis* and *Streptococcus faecalis* R5 in all portions of the pie. Investigations of methods of meringue production revealed that the addition of hot sugar syrup to egg white results in a pasteurizing effect. Under uncontrolled commercial conditions a reduction as high as 99 per cent was observed in the expected total count when the meringue reached a temperature of 125°F. Data of laboratory experiments indicating the effects of several variables on the temperature and on the bactericidal effect will be presented.

A7. *Comparison of fermentation and enzyme treatment methods for the removal of glucose from egg albumen.* JOHN C. AYRES. Food Process Laboratory, Iowa State College, Ames. Egg albumen contains approximately 0.4 per cent