

Recommendations for Safe Production of Fermented Vegetables



Vegetables may be preserved by fermentation, direct acidification, or a combination of these methods along with other processing conditions and additives (1). Fermented foods generally have a good safety record, but improperly fermented foods may be unsafe (2). The fermentation of vegetables is primarily due to the lactic acid bacteria, although yeasts and other microorganisms may be involved, depending on the salt concentration and other factors. Salt serves two primary roles in the preservation of fermented vegetables: it influences the type and extent of microbial activity, and it helps prevent softening of the vegetable tissue.

The safety of food fermentation is related to several principles:

1. Food substrates overgrown with desirable, edible organisms do not support growth, or sometimes survival, by invasion by spoilage or food poisoning microorganisms. These undesirable organisms find it difficult to compete.
2. Fermentations involving production of lactic acid are generally safe. During lactic acid fermentation, fermentable sugars are converted to lactic acid. For example, in the production of sauerkraut, fresh cabbage is shredded and 2.25% salt is added. There is a sequence of lactic acid bacteria that grow: *Leuconostoc mesenteroides* grows first, producing lactic acid, acetic acid and carbon dioxide. Then *Lactobacillus brevis* grows, producing more acid. Finally *Lactobacillus planarum* grows, producing still more lactic acid and lowering the pH to below 4.0. At this pH and under anaerobic conditions, the cabbage and other vegetables will be preserved for long periods of time.

There have been no reports of pathogenic microorganisms associated with standard commercial pickle products prepared under 'good manufacturing practices' and having appropriate acid, salt, and sugar content (1). However, *Listeria monocytogenes*, a foodborne pathogen, has been isolated from various plant foods and fermented materials, and this fact, coupled with the bacterium's ability to tolerate moderately low pH and high salt concentration, suggests that *Listeria* may pose a concern in vegetables that are not effectively fermented. Insufficient acid production and anaerobic fermentation conditions may also establish conditions under which *Clostridium botulinum* may grow and produce a harmful neurotoxin.

Critical factors in the production of safe fermented foods are the correct level of salt, proper fermentation temperature, and sufficient acid production. The correct level of salt varies by food product, ranging from 2.25% for sauerkraut to greater than 13% for some

fermented meats. Since consumers can not easily measure salt concentration in a finished product, salt should be carefully measured, and a tested recipe followed, in the preparation of naturally fermented foods. Salt used in fermentation is generally 'canning and pickling salt;' table salt, kosher salt, or other types of salt can not be used interchangeably with canning and pickling salt (3).

Proper fermentation temperature selects for desired fermentation organisms and inhibits the growth of spoilage organisms. Most products are fermented at temperatures between 68°F and 75°F. In this temperature range, fermentation generally takes 3 to 4 weeks; at 60°F to 65°F, fermentation will proceed more slowly and may take 5 to 6 weeks. Fermentation at temperatures above 75°F may result in spoilage.

Sufficient acid production is critical to safety of fermented products. Enough acid to lower the equilibrium pH to 4.6 or below is necessary for safety. Ideally, pH will be checked during fermentation to track the progress of the reaction. A final equilibrium pH of 4.6 or below must be achieved.

Research-tested recipes for fermented products are available online:

- Homemade Pickles and Relishes <http://learningstore.uwex.edu/pdf/B2267.PDF>
- Make Your Own Sauerkraut <http://learningstore.uwex.edu/pdf/B2087.pdf>

References:

1. Fleming, H.P., R.F. McFeeters, and M.A. Daeschel. 1992. Fermented and acidified vegetables in *Compendium of Methods for the Microbiological Examination of Foods*. American Public Health Association, Washington, D.C.
2. Steinkraus, K.H. 1997. Classification of fermented foods: worldwide review of household fermentation techniques. *Food Control* 8:311-317.
3. Ingham, B. 2008. Homemade pickles and relishes. University of Wisconsin Extension bulletin B2267.