Vegetable Fermentation:

Fermented food: Foods that have been subjected to the action of microorganisms or enzymes, in order to bring about a desirable change. Microorganisms cause changes in the foods which:

- Help to preserve the food.
- Extend shelf-life considerably over that of the raw materials from which they are made.
- Improve aroma and flavour characteristics.
- Increase its vitamin content or its digestibility compared to the raw materials.

Numerous food products owe their production and characteristics to the fermentative activities of microorganisms. Fermented foods originated many thousands of years ago when presumably micro-organism contaminated local foods.

Vegetables for pickling are harvested while still immature as fully ripened vegetables are too soft for most commercial uses.

The fermentation is due to lactic acid bacteria, although yeasts and other microorganisms may be involved depending on the salt concentration and other factors.

To prevent defective fermentation, brines with high salt concentration are sometime used in order to regulate the type and extent of microbial growth, as well as to prevent softening the product.

The application of starter culture in controlled fermentations to obtain high quality end product as well as to reduce the amount of west brine which can result in significant environmental pollution problem.

The microflora of fresh vegetables is mainly dominated by Gram negative aerobic bacteria and yeasts while lactic acid bacteria constitute a small portion in the initial population.

Most vegetables with the addition of salt brine (not exceed 8% concentration), under anaerobic conditions and appropriate temperature, undergo a spontaneous lactic acid fermentation during which lactic acid bacteria have a competitive advantage.

The species of lactic acid bacteria most associated with the natural fermentation of vegetables are: *Pediococcus pentosaceus*, *Lactobacillus brevis* and *lactobacillus plantarum.* While *Pediococcus* species tolerant a minimum pH of 4.0 for growth, *lactobacillus* species are the most acid tolerant, with a minimum pH of 3.8. As fermentation proceeds and the acidity increases, lactobacilli start to take over from the cocci. The growth of lactic acid bacteria depends on the available nutrients, salt concentration, pH value, and temperature of the environment. Changes of these parameters influence the dominant organisms. Organisms such as *leuconostoc mesenteroides* are usually inhibited in the brine by the higher salt concentration, temperature and rapid pH drop. The addition of salt and the rapid production of organic acid suppress the Gram negative bacteria, which the lactic acid bacteria are the outnumber on the products.

The active stage of fermentation continues for between 10 to 30 days, depending upon the temperature of the fermentation. During the fermentative period, the acidity increases to about 2% and the strong acid producing types of bacteria reach their maximum growth. If sugar or acetic acid is added to the fermenting mixture during this time it increases the production of acid.

❖ The fermentation of vegetables, such as cucumbers, cabbage, and olives, occurs in a series of stages:

1- **Initiation stage**: In the initial stage Gram-positive and Gram-negative microorganisms naturally present on the vegetables may grow.

2- **Primary fermentation stage**: During the primary fermentation, growth of lactic acid bacteria occurs with or without fermentative yeast.

3- **Secondary fermentation:** Secondary fermentation occurs if fermentable carbohydrates remain after the primary fermentation, which can be assimilated by fermentative yeasts while lactic acid bacteria are inhibited by low pH.

4- **Post-fermentation stage:** Post-fermentation is characterized by the depletion of fermentable carbohydrates and the absence of microbial growth under anaerobic conditions.

Sauerkraut (acid cabbage**)**: is one example of an acid fermentation of vegetables. The 'sauerkraut process' can be applied to any other suitable type of vegetable product.

Is the clean product, of characteristics flavor, obtained by full fermentation, chiefly lactic acid, of property prepared and shredded cabbage in the presence of not less than2% and not more than 3% salt. It contains, upon completion of the fermentation, not less than 1-1.5% as acid expressed as lactic acid.

Problems in pickles:

The production of excessive amounts of acid during the fermentation, results in shriveling of the pickles, possibly due to over-activity of the *L. mesenteroides* species. If the brine is stirred, it may introduce air, which makes conditions more favorable for the growth of spoilage bacteria. In general, if the pickles are well covered with brine, the salt concentration is maintained and the temperature is at an optimum, it should be quite simple to produce good quality pickles.

Procedure:

1. The heads of cabbage preferred for kraut making are wilted for 1-2 days to bring the cabbage to a uniform temperature and facilitate shredding.
2. Spoiled spots and defective outer leaves are trimmed off by washing the head with pure water and the head is cut to shred of desired size.
3. Add 2.25-2.5% of salt and mixed it with the shredded cabbage.
4. The shred has been packed in the vat.
5. Weighted down so that a layer of brined juice stands on the surface.
6. Cover the product to protect the surface from contamination with dirt or insects.
7. When the desired acidity has been attained, the fermentation is stopped by heat treatment during canning or by low temperature.
8. Good sauerkraut should be light colored and crisp, with an acidity of about 1.7% and a clean acid flavor.