FOOD FERMENTATIONS - FAQs

1. What are the advantages of fermented dairy products?

   The main advantages of fermented dairy products include better digestibility, enhanced absorption of milk proteins, improved digestibility of milk fat, reduction of lactose content, enhanced retention of minerals such as calcium, enhanced availability of certain B-vitamins and production of other metabolites, i.e., flavor compounds, by starters, etc.

2. What are starter cultures? Describe the role of starter cultures.

   Starter cultures are the selected microbial cultures that are used to prepare quality fermented foods with desirable characteristics. The primary role of starter cultures is to develop acidity in the products and it is mainly lactic acid, in the case of fermented dairy products. It is generated by the metabolic action of starters on the sugar present in the milk, lactose. In the presence of this acid, the proteins present in the milk, casein, gets coagulated resulting in the formation of curd. The secondary function of this acid development is expulsion of moisture, especially in cheese preparation, flavour development and texture formation. This acidity also prevents the growth of undesirable microbes in the fermented products and imparts pleasant flavour to the product. The lipolytic activity results in the formation of fatty acids from the milk fat, which imparts good flavour to the products. Some of the starters also produce bacteriocins, short chain peptides, which have antimicrobial activity against pathogens and also on closely related lactic acid bacteria. Ex: nisin, diplococcin, acidophilin, bulgarin, pediocin, etc.

3. Explain about various types of starter cultures.

   Dairy starter cultures are of three types. These are bacteria, molds and yeasts. The bacterial starters can further be classified based on their shape, type of acids produced, temperature requirement for the growth, ability to produce one or more compounds from glucose, etc. Based on the requirement of growth temperature dairy lactic starters can be classified as mesophilic starters and thermophilic starters. Mesophlic starters include, *Lactococcus lactis* sub sp. *lactis*, *Lc. lactis* sub sp. *cremoris*, *Lc. lactis* sub sp. *diacetylactis*, *Leuconostoc mesenteroides*, *Leu. dextranicum*, *Leu. citrovorum*, etc. Thermophilic starters include *Streptococcus thermophilus*, *Lactobacillus plantarum*, *Lb. bulgaricus*, *Lb. brevis*, *Lb. acidophilus*, etc. Based on the ability to produce one or more metabolites by using the lactose, dairy starters can be classified as homofermentative and heterofermentative starters. Homofermenters (*Lc. lactis* sub sp. *diacetylactis*, *Leuconostoc mesenteroides*) produce only lactic acid from the sugar through hexose diphosphate pathway, for ex. lactic acid from lactose, whereas, heterofermenters (*Lactococcus lactis* sub sp. *lactis*, *Lc. lactis* sub sp. *cremoris*, *Lb. plantarum*) besides lactic acid, produce other compounds (ethanol, CO_2, acetic acid, etc.) via hexose monophosphate pathway during the fermentation. The molds that are being used as starter cultures can be classified as white molds, blue molds and others. The molds used in cheese preparation like *Penicillium camemberti*, *P. candidum* are examples to white molds. *P. roqueforti* is known as blue mold. *Saccharomyces kefir*, otherwise known as

Saccharomyces lactis or *Torula kefir* or *Candida kefir* is used in the preparation of kefir, an acid-alcohol type of fermented dairy product.

4. Distinguish technical starters and therapeutic starters.

   Based on the primary function starter cultures can be classified into Technical starters and therapeutic starters. Technical starters are good fermenting cultures. They help to produce palatable products. However, they do not resist acid environment, stomach bile, etc. Whereas, therapeutic starters resist high acid levels and bile tolerant. They survive passage through the stomach and establish in the small intestine. They can influence health and help in longevity of the consumers by inhibiting the growth of unwanted microbes in small intestines.

5. What are the characteristics of a good starter?

   The characteristics of a good starter are they must produce sufficient acid, must continue acid production over the entire range of temperature, should be resistant to antibiotics and bacteriophages, should be active in the presence of residual chemicals/sanitizers/ detergents, must not produce undesirable body characteristics, flavour and aroma. In mixed cultures, the associative action must be quite stable, even after repeated subcultures.

6. What are the therapeutic benefits of lactic cultures?

   Some of the lactic cultures can provide several therapeutic benefits to the consumers, if consumed regularly. These include, antimicrobial activity against pathogens like *E. coli, Staph. aureus, Salmonella, Clostridium, Listeria,* etc. They have anticarcinogenic activity and remove precarcinogens or enzymes that can cause cancers. They reduce cholesterol content by inhibiting the key enzyme of cholesterol synthesis, hydroxy methyl glutaryl COA reductase. They reduce lactose intolerance by predigesting lactose. They also produce vitamin B_1, B_6 B_{12}, etc.

7. What are probiotics? Give some examples.

   Probiotics are selected microbial cultures, which can exert health benefits upon regular consumption. Probiotics are defined as "live microorganism which when ingested in sufficient numbers provide health benefit to the consumer beyond basic inherent nutrition". The foods containing these live organisms are called probiotic foods. The minimum number of probiotic microbes to give health benefits is said to be one million live cells per gram of the product. Some of the examples to probiotics are *Lb. acidophilus, Lb. rhamnosus, Lb. reuteri, Lb. casei, Lb. plantarum, Bifidoabcterium bifidum, Bif. longum, Saccharmyces boulardi*, etc. The term probiotics consist of two Greek words, i.e., *Pro* meaning 'For' and *Biotics* meaning 'Life' and the foods containing the live probiotic organisms are known as probiotic foods.

8. What is sauerkraut? Expalin the role of microbes in its production.

Sauerkraut is a vegetable fermented food produced due to the action of lactic cultures on cabbage. It is popular in Europe and Oriental countries. Exclusion of air and judicious use of salt and temperature leads to prolific growth of lactic acid bacteria (LAB). Anaerobiosis restricts growth of *Pseudomonas, Flavobacterium, Acinitobacter*, moulds, oxidative yeasts, etc. The LAB count increases from 1% to 90% in 2 days at 21°C. The pH drops from 6.2 to 4.5, which inhibits undesirable microbes. *Leuconostoc mesenteroides* dominates early phase (because of the short lag period and generation time) and initiates acid production. With the increase in lactic acid production *Leuconostoc* activity decreases and *Lb. plantarum* and *Pediococcus cerevisiae* dominates. High level of salt encourages the preferential development of these two organisms leading to high sour flavour. Temperatures above 30°C suppress growth of *Leuconostoc* sp., which results in losses in quality with regard to flavour, colour and texture. The addition of salt to cabbage extracts nutrients from cabbage, which are vital for the establishment of proper microflora. It inhibits the growth of undesirable microorganisms. Salt maintains structural integrity of the shreds and promotes flavour enhancement in the finished product.

9. What are the advantageous of fermentation of cereals and indicate various types of fermentation of cereals?

Fermentation of cereals significantly improves the protein quality as well as the level of lysine in maize, millet, sorghum, and other cereals. Natural fermentation of cereals leads to a decrease in the level of carbohydrates as well as some non-digestible poly and oligosaccharides. Availability of B group vitamins may be improved. The antinutritional factors like phytate are reduced. Fermentation increases the amount of soluble iron, zinc and calcium several folds. During cereal fermentations several volatile compounds are formed, which contribute to a complex blend of flavours in the products. In the fermentation of cereals four basic technologies can be identified. They are malting, i.e., the management of endogenous activities, koji technology, i.e., the use of physiological fungal activities, use of hydrolytic activities originating from external enzyme sources, e.g., from fungi, bacteria, plants or human saliva and dough (batter or gruel) fermentation.

10. What is soy sauce? How it is produced?

Soy sauce is a well-known Oriental fermented cereal based product. It is being used for centuries in East Asian countries. It is a dark coloured salty sauce made from fermenting boiled soybeans and roasted wheat grains. There are two stages in soy sauce fermentation. The first stage is a low salt solid state fermentation carried out by *Aspergillus oryzae* (48 h). The second stage is a high salt liquid fermentation mediated by lactic acid bacteria and yeast, which may take a few months to even three years. This step is known as moromi fermentation. After this step it is heated and filtered to separate insoluble proteins. Later it is packed and pasteurized. Thus a dark salty soy sauce is produced.

11. What are the benefits of fermentation for making tempeh?

Tempeh is prepared by fermenting with *Rhizopus* culture using the dehulled soy beans after soaking and cooking. Primary benefits of soybean fermentation are the improvement of organoleptic quality and nutritional value. Raw soybeans are bitter in taste. Consecutive stages of the tempeh fermentation processes (soaking, leaching and enzymatic modification) result in the removal of the beany flavours. Fermentation results in delicious new flavours and aroma, creating a unique texture and appearance, while simultaneously enhancing the nutritional value and digestibility. Proteases, lipases, a variety of carbohydrases, and phytases are produced. This results in decrease of anti-nutritional factors. During fermentation flatulence causing raffinose and stachyose are removed mainly by soaking and cooking of soybeans. Several tempeh-forming *Rhizopus* spp. can utilize these as their sole source of carbon and energy. Dietary fibre increases from 3.7 to 5.8% because of the growth of mould mycelia. The increased content of some vitamins of the B group, especially riboflavin, niacin, vitamin B6, and vitamin B12, because of fungal and bacterial metabolic activities. Carotenoids are formed in small amounts.

12. How vinegar is produced?

Vinegar is an important commodity most frequently used as a preservative. It is produced by converting ethanol by the action of acetic acid bacteria. Initially in the first step, fruit juices/ hydrolysed cereals/ starches or barely malt are fermented anaerobically by yeasts (*Saccharomyces* sp.) to convert the sugars into alcohol. In the second step, this alcohol is converted into vinegar by acetic acid bacteria through a highly aerobic fermentation. It contains around 4-5% acetic acid.

13. Write about various methods of vinegar fermentation.

Vinegar can be produced in three methods. They are natural spontaneous fermentation, the quick vinegar method and the Orleans process. In the first method, sugar palm or coconut sap is allowed to ferment naturally till it becomes sour and it is packed in coke bottles. In quick method (Germen method), a tank filled with beechwood shavings is kept in upright position and acetic acid bacteria are added to it. The alcohol solution is allowed to trickle down over it and oxygen is allowed to enter the tank. Oxidation of alcohol results in vinegar. In Orleans process, which originated in France (oldest, slow and continuous method), high grade vinegar is used to start the fermentation in wooden barrels of 200 L capacity. Wine is added at weekly intervals and after four weeks, vinegar is collected from the barrel. A gelatinous pellicle forms over the surface of the liquid due to the production of exopolysaccharides (cellulose) by the acetic acid bacteria.