

# **FERMENTED FOOD: DOSA**

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## **Learning Objectives:**

After reading this section, you should be able to:

- ❖ Outline the process by which Dosa is made
- ❖ About the nutritional value of white rice and blackgram used in dosa
- ❖ About Heterolactic acid fermentation and homolactic acid fermentation
- ❖ What are the health benefits of consuming fermented product like dosa

# Dosa:

❖ It is a type of pancake made from fermented batter of rice and blackgram.

## ❖ Preparation and serving:

Mixture of rice and black grams (usually 2:1) soaked in water overnight and is finely ground to form a batter and a pinch of salt is added.



The batter is then allowed to ferment for overnight and then mixed with water to get the desired consistency.



The batter is then ladled onto a hot griddle greased with oil or clarified butter. It is spread out evenly with the base of a ladle to form a pancake.



Typical dosa is served hot along with vegetable soup (sambar), potato curry and coconut-chilly sauce (chutney) (Fig.1), but now a day, one can find hundreds of varieties of dosa depending upon their taste and preferences.



**Fig1: Typical Crispy Dosa**



**Fig2: Various types of Dosa**

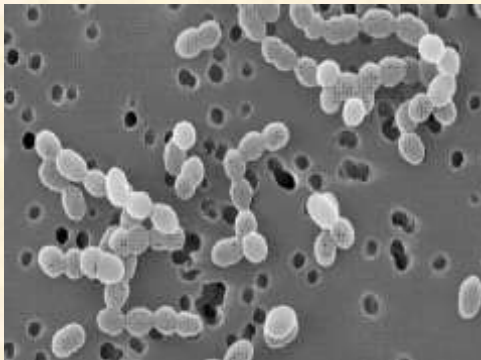
❖ **Nutrition:** The main ingredients of dosa are rice (*Oryza sativa*) and blackgram (*Phaseolus mungo*).

❖ **White rice**, which is normally used for dosa, contains about 90% carbohydrates, 8 percent proteins and 2% fat. It is also a good source of calcium, magnesium, phosphorus, manganese, selenium, iron and vitamins, folic acid, thiamine and niacin. It has low fiber content and contains pro-inflammatory omega-6 fatty acids.

❖ **Black gram or Mungo bean** is rich in carbohydrates (about 60%) and proteins (about 25%), It also contains about 18% of dietary fiber and is a good source of minerals, potassium, calcium, iron and vitamins, niacin, thiamine, and riboflavin. Black gram has been found to be very useful in controlling cholesterol levels.

❖ **Water:** Water is important to maintain the consistency (swelling and gelatinization) of the dosa batter. It acts as a solvent medium for sugars and other substrates of fermentation process and also for enzymes. Water also acts as a source for the various microorganisms and minerals needed for the fermentation process.

❖ **Fermentation:** Fermentation gives the characteristic texture (leavening), aroma and taste to the dosa batter along with improved digestibility and nutritional value. Fermentation is the process of converting carbohydrates to alcohol or organic acids with the help of microorganisms, under oxygen free conditions.



*Leuconostoc mesenteroides*



*Lactococcus lactis*



Leavening of the batter due to fermentation

The microorganisms responsible for the fermentation are naturally present in the ingredients of dosa batter, black gram and rice. A temperature of 25°-30° C is found to be highly favorable for the microorganisms to boost the fermentation process.

Fermentation of dosa batter is carried out mainly by Lactobacillales or lactic acid bacteria (bacteria that convert milk to yogurt), recognized as *Lactobacillus delbrueckii*, *L. lactis*, *Streptococcus lactis*, *S. faecalis*, *Leuconostoc mesenteroides* and *Pedococcus cerevisiae*.

Wild yeasts, recognized as *Saccharomyces cerevisiae*, *Debaryomyces hansenii* and *Trichosporon beigelli*, on the other hand, are found to produce flavor compounds and help in the saccharification (hydrolysis) of starch. In the early stages of fermentation, the 'heterofermentative' type bacteria like *Leuconostoc mesenteroides* (Fig. 3) are found to predominate, producing carbon dioxide and alcohol along with the lactic acid (the mucilagenous property of dosa batter helps to trap the carbon-dioxide evolved during fermentation which results into leavening of the batter).

During the later stages of the fermentation the homofermentative lactic acid bacteria like *Lactococcus lactis* (Fig. 4) dominate and produce only lactic acid. Due to this batter starts turning sour over the time.

Starch in the rice and black gram (or in general) contains two types of homopolysaccharides, *amylose* and *amylopectin*. Amylose is an unbranched homopolysaccharide consisting of about 5-600 glucose units, linked by  $\alpha$ -(1→4) glycosidic bonds.

It forms a helix structure with six glucose units in each helix. Amylopectin is a branched molecule formed by several glucose units ranging from several hundreds to fifty thousand in a main chain, which are joined by  $\alpha$ -(1→4) glycosidic bonds.



During the fermentation process the starch content of the dosa batter is hydrolysed (broken down) yielding maltotriose and maltose from amylose, or maltose, glucose and limit dextrin from amylopectin, with the help of amylases, the calcium metalloenzymes. These amylase enzymes (mainly  $\alpha$ -amylase,  $\beta$ -amylase and  $\gamma$ -amylase) are provided by the microorganisms (yeasts and bacteria) naturally present in the ingredients of dosa batter and the atmosphere.



Fig 3: Heterolactic acid Fermentation

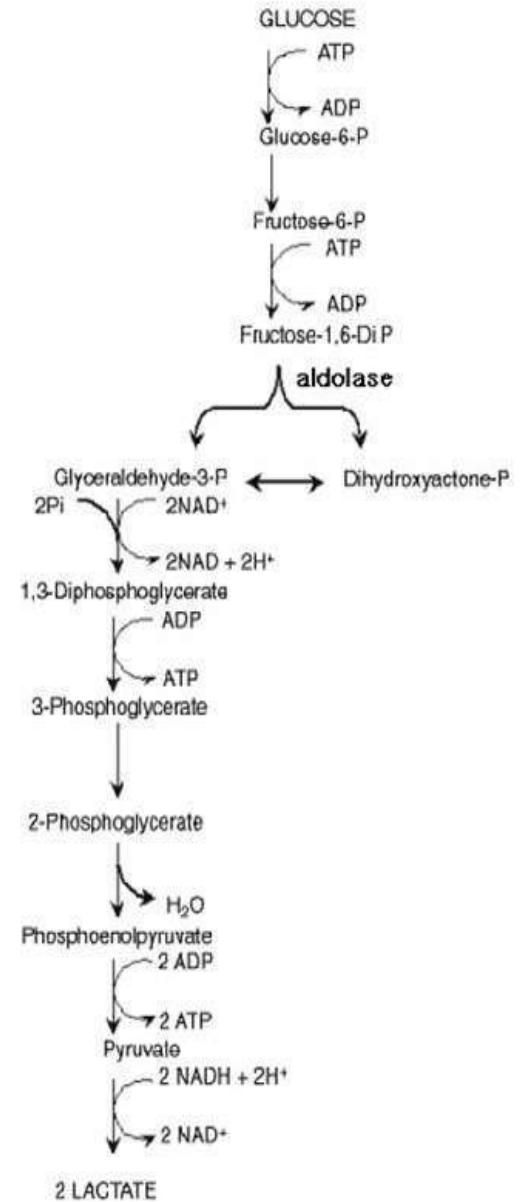
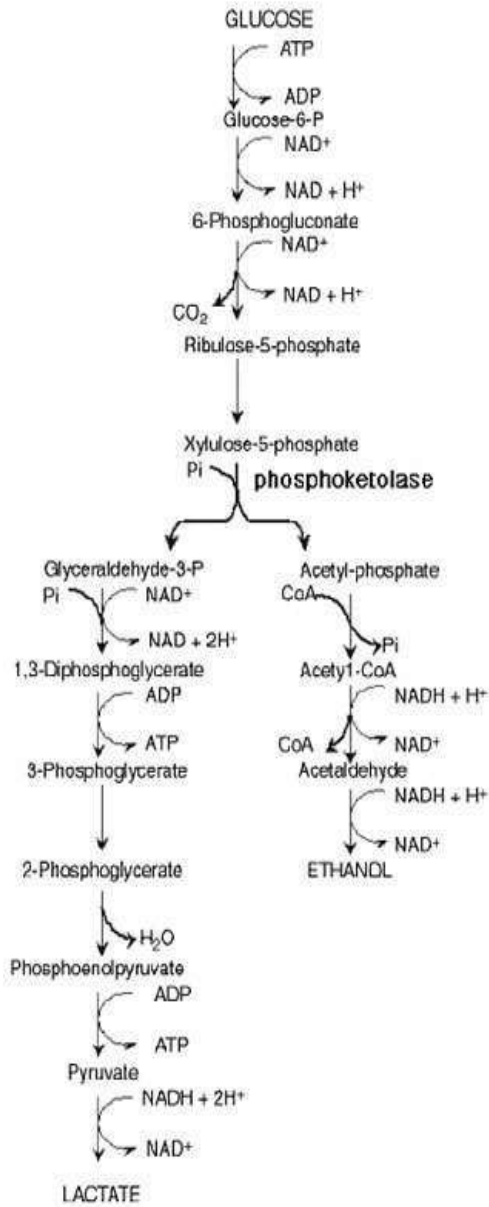


Fig 4: Homolactic acid Fermentation

**Benefits of fermentation:** Fermentation process helps to break down the anti-nutrients like phytic acid present in rice and blackgram (phytic acid is known to block the mineral absorption and cause deficiencies).

The microorganisms involved in the fermentation also produce useful substances like vitamins, folic acid, riboflavin, niacin, thiamin, biotin, vitamin K and some free amino acids as well as some antibiotic and anti-carcinogenic substances, hence increasing the total nutritional value of the dosa. Since dosa batter is predigested by bacteria, it is easier to digest.

The lactic acid formed during the fermentation process, along with the various enzymes, aid the digestion of food, especially protein digestion.

Lactic acid formed during fermentation not only preserves the food but also promotes the growth of a healthy intestinal flora. Lactobacilli are known to promote digestive health by inhibiting bacteria like Shigella, Salmonella and E.coli.

**Utility of using salt:** Presence of salt helps to control the fermentation process. It slows down the yeast action and helps the liberation of yeasts enzymes and other useful substances into the batter via osmosis. Since the lactic acid bacteria can tolerate high salt concentrations, the presence of salt gives them an advantage over other less tolerant species and allows the lactic acid fermenters to start the metabolism, which produces lactic acid, which further inhibits the growth of non-desirable organisms. Further addition of salt increases the mineral value of the dosa and the taste.

**Different Types of Dosa:** Rava Dosa, Masala Dosa, Set Dosa, Neer Dosa, Ragi dosa, Paneer Dosa.



## **Activity**

- 1) Which microorganisms are responsible for causing leavening of the dosa batter and how they do it?
- 2) Why we add salt in the batter?
- 3) Discuss the nutritional value of using white rice and black gram in dosa batter.
- 4) Which microorganisms are used during dosa fermentation process?



## **Conclusion**

Here we have described a limited section of fermented foods in which we illustrates how they produce, their diversity, health benefits and importance of consuming them, their nutritional value as well as microbial contributions during their production at a industrial level.

## **References:**

- 1) **Prescott's Microbiology** by Wiley, Sherwood and Woolverton (10<sup>th</sup> edition) : McGraw-Hill International Edition
- 2) **Principles of Microbiology** by Ronald M. Atlas (2<sup>nd</sup> edition): McGraw-Hill Indian Edition
- 3) **Food Microbiology by Frazier and Westhoff** (5<sup>th</sup> Edition): McGraw-Hill Education
- 4) **Food Microbiology by Adams and Moss** : New Age International Publishers

**THANK YOU**