PROCESSING OF PICKLES

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Pickles are usually made from a mixture of vegetables and fruit. They are eaten as a savoury, spicy accompaniment to a meal. Pickles are preserved by a combination of increased acidity (reduced pH), added salt, reduced moisture and added spices. Pickles can be prepared using one of two main methods: lactic acid fermentation of vegetables, either with or without the addition of salt the preservation of vegetables in acetic acid (vinegar). The products made by these two methods are very different -each one has its own distinctive taste and texture. Vegetables such as cucumber, cabbage, olive and onion are fermented by lactic acid bacteria which can grow in low concentrations of salt.

The bacteria ferment sugars in the food to form lactic acid, which then prevents the growth of food poisoning bacteria and moulds. The amount of salt added controls the type and rate of the fermentation. If 2-5% salt is used, the fermentation is carried out by a series of bacteria that produce lactic acid. The pickle is preserved by the high level of acidity. If higher levels of salt are used (up to 16%) the product is preserved by the high salt concentration rather than by fermentation and is known as a salt-stock pickle. Fruit and vegetables can be semi-processed and stored for many months by preserving in a high salt solution. They can be further processed into pickle later in the season.

Sometimes sugar is added to increase the rate of fermentation or to make the product sweeter. Pickles prepared by fermentation are not heated, therefore strict attention must be paid to cleanliness and hygiene. The concentration of salt, pH of the mixture and temperature of fermentation must all be controlled to ensure a good fermentation and to prevent the growth of undesirable bacteria. Vegetables pickled in acetic acid (vinegar) have salt and sugar added. They are not fermented and therefore have a different texture and flavour.

The preservation of fruits and vegetables in the form of pickles, chutneys and sauces began as a household art, but at present major part of the world's supply of these are produced in commercial plants. The basic raw materials, quality control, brining, physico-chemical aspects, texture, colour, flavour, composition, packaging, processing, storage, new recipes

and automation / mechanization determines the type and variety of pickles. Fruits and vegetables preserved in common salt, vinegar, oil or citrus fruit juice are called pickles. Mango, lime, carrot, bitter gourd, beans, chillies, garlic, ginger, brinjal and onion are mainly processed for pickles.

Different types of pickles

Commercially available pickles are of two types. 1) Fermented pickles and 2) Unfermented pickles. Fermented pickles are classified as:

a) Brine pickle
b) Oil pickle
c) Vinegar pickle
d) Sweet pickle

1. **Brine pickle:** Salt cured pieces are freshened and preserved in fresh brine and vinegar. For brine pickles minimum prescribed salt of 8 to 12 per cent is permitted. Sometimes even 16 per cent salt is also added. Additions of spices help to improve the flavour of brine pickles.

2. **Oil pickles:** The salt stock is washed to reduce the salt to 5-6 per cent and covered with oil. Cured Mango, lime, gooseberry, chillies and mixed vegetables are pickled with 5 to 6 per cent salts. The contents are left for four to eight days with occasional mixing. Edible oil is poured over the pickle to form a thick layer. Oil layer creates an anaerobic condition.

3. **Vinegar pickle:** The brine is drained from the salt cured product, excess salt is removed and the material is kept in plain vinegar with 2 to 3 per cent salt for several weeks. Vinegar is added to 1/3 of total product.

4. **Sweet pickle:** Salt cured pieces are freshened and pickles are prepared with addition of sugar or jaggery and selective spices. Salt concentration of 5 - 8 per cent and sugar 40 - 60 per cent are added.

5. **Unfermented pickles:** In some pickles such as lime, lemon, immature mango, pickles are prepared without undergoing fermentation.

Various types of pickles

Product	Salt	Sugar	Vinegar	Process
Fermented sweet pickle	5% then 3%	1-2% then 3%	0 then 5%	Ferment for 1-2 weeks then repacked in vinegar+ salt+ sugar (optional pasteurisation)
Fermented sour pickle	5% then 3%	0 then 0	0 then 5%	Ferment for 1-2 weeks then repack in vinegar + salt (optional pasteurisation).
Unfermented pickle	3%	1%	5%	Pack straight away and pasteurise.
Salt-stock pickle	15%	0	0	Store until required. Wash out salt and repack as unfermented pickle.

Preparation of pickles (Fermented Pickles)

Suitability for small-scale production:

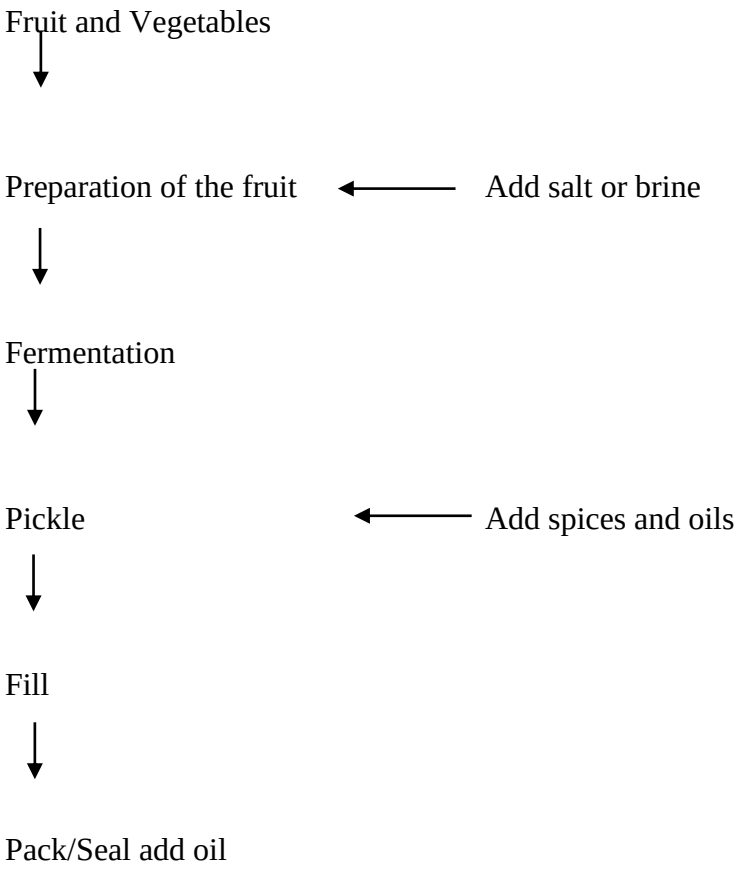
Pickles are fairly safe products for small-scale manufacturers to make. When preserved properly they carry a low risk of food poisoning and have a long shelf life. Pickles can be made using relatively simple equipment that is readily available in most places. Pickles can be prepared from a variety of fruits and vegetables depending on what is available. By varying the proportions of fruit and vegetables and the amount of spice added, a range of products can easily be made.

Constraints to production:

Many small-scale processors choose to make pickle as it is relatively easy. There may be a high level of competition. The conditions for fermentation (temperature, pH and salt content) need to be closely monitored to ensure a good product. The availability of acetic acid may be a problem in some areas. It is essential that a survey is carried out to determine the potential market for the

product before starting on production. A successful business depends on a good market for the product. Too often, small-scale processors decide to make pickles because there is an abundant supply of raw material, with no evaluation of the demand for the product. These type of ventures usually fail.

Flow Sheet for the Preparation of Pickles



1. Preparation of the fruit:

Fruit should be washed in clean water, peeled and the stones removed. Stainless steel knives should be used to cut the fruit into uniform-sized pieces. Most fruits are cut into small strips. Fruit should be as fresh as possible and slightly under-ripe. Damaged, bruised or infected fruits should not be used. Accurate scales are needed to make sure that the correct amounts of ingredients are used each time. Two sets of scales are needed - one with a large capacity for sugar and fruit and a smaller set for the spices. For fermented pickles, the peeled fruit and vegetable pieces should be held in a 2-3% salt solution to prevent browning of the surfaces. For

non-fermented pickles, vinegar, spices and sugar are added before the mixture is heated. Oil is sometimes added to the mixture

2. Fermentation:

Prepared vegetables are placed in the fermentation container and salt or brine is added. The vegetable pieces are weighted down so that they are submerged in the brine. The vegetables and salt are placed in alternate layers until the container is three quarters full. As a guide, 3kg salt is required for every 100kg vegetables. A container with a lid should be used for fermentation. This is to maintain the temperature at the optimum level and to prevent contamination from dust and insects. If brine is being used, a 15-20% brine solution is prepared by dissolving salt in water. This is measured using a salometer or brine hydrometer. A starter culture of juice from a previous fermentation may be added to speed up the fermentation. The temperature and time of fermentation must be carefully controlled. The optimum temperature is 21°C. Fermentation begins as soon as a brine is formed. It can be seen by bubbles of carbon dioxide gas that are given off by the bacteria. Fermentation takes between one and four weeks depending upon the temperature, pH and strength of the salt solution. It is completed when no more bubbles appear.

3. Measurement of salt concentration:

The concentration of salt in pickling brines can be measured using a brine hydrometer. A sample of brine at 20°C is filled into a large clear glass or plastic cylinder and the hydrometer placed in the liquid. When the hydrometer has stopped moving, the scale is read at the surface of the liquid. The reading is converted to % salt using a conversion table suppled with the hydrometer.

The principles of lactic acid fermentation

Lactic acid bacteria are a group of bacteria that produce lactic acid by the fermentation of carbohydrates. They are the most desirable group of bacteria in food preservation. They play important roles in the fermentation of many foods including sour dough bread, sorghum beer, fermented milks, fermented cassava and pickled vegetables. The lactic acid bacteria are a diverse group of organisms that occur naturally. They are very adaptable to a range of conditions.

The fermentations carried out by lactic acid bacteria do not require oxygen to be present. Because of this, the fermentation does not cause drastic changes to the composition of the food. The whole basis of lactic acid fermentation centres on the ability of lactic acid bacteria to produce acid, which then inhibits the growth of other non-desirable organisms.

A typical lactic acid fermentation involves several types of lactic acid bacteria, all of which are tolerant of different temperatures and acid concentrations and which produce different compounds that give the pickles their characteristic taste.

The main groups of lactic acid bacteria involved in the fermentation of vegetables are as follows:

Leuconostoc mesenteroides:	Produces acid and gas
Lactobacillus plantarum:	Produce acid and a small amount of gas
Lactobacillus cucumeris:	Produce acid and a small amount of gas
Lactobacillus pentoaceticus:	Produces acid and gas

There are also a range of undesirable bacteria present on the surface of vegetables that can interfere with the fermentation process if they are allowed to grow unchecked. The quality of fermented vegetables depends on how well the undesirable organisms are controlled during fermentation. In a typical fermentation the first micro-organisms are the Leuconostoc mesenteroides. They produce lactic acid until it reaches a concentration of 0.25-0.3% As the acidity increases, the Leuconostoc species start to die off and the Lactobacilli species (plantarum and cucumeris) take over. These Lactobacilli continue until the acidity is 1.5-2.0%. They are inhibited by low temperature and high salt concentration. The last bacteria in the chain are the Lactobacilli pentoaceticus that continue the fermentation until the acidity is 2-2.5%.

The end products of a normal fermentation are lactic acid along with smaller amounts of acetic acid and propionic acids, gases, small amounts of alcohol and a mixture of aromatic compounds. These all contribute to the preservation and characteristic taste of pickled vegetables.

Factors that affect fermentation

Fermentation is affected by several factors including the temperature, salt concentration, pH, oxygen availability and nutrient availability. The rate of fermentation can be controlled by manipulating any of these factors.

i) **Temperature:** Different bacteria tolerate different temperatures. Most have an optimum of between 20-30°C although some prefer higher temperatures (50-55°C) and others colder (15-20°C). Most lactic acid bacteria work best at temperatures of 18-22°C. The Leuconostoc species which initiate fermentation have an optimum of 18-22°C. The Lactobacillus species have temperature optima above 22°C. The optimum temperature for pickle fermentation is around 21°C. A variation of just a few degrees from this temperature alters the activity of the microbes and affects the quality of the final product.

ii) **Salt concentration:** Lactic acid bacteria tolerate high salt concentrations, which gives them an advantage over other less tolerant species. This allows the lactic acid fermenters to begin metabolism, which produces acid, which then further inhibits the growth of non-desirable organisms. Leuconostoc species tolerate high salt concentrations, which makes them ideal to start the lactic acid fermentation. Salt plays an important role in initiating the fermentation and also in the quality of the product. The addition of too much salt may inhibit the desirable bacteria and also affect the hardness of the product. The principle function of salt is to withdraw juice from the vegetables and make a favourable environment for fermentation. Salt is generally added to give a final concentration of 2.0-2.5%. At this concentration the Lactobacilli are slightly inhibited but the Leuconostoc are not affected

iii) **pH:** The optimum pH for most bacteria is near the neutral point (pH 7.0). Certain bacteria are acid tolerant and will survive at reduced pH levels. Both Lactobacillus and Streptococcus species are acid tolerant.

iv) **Oxygen availability:** Some of the fermenters are anaerobes while others require oxygen. Some of the lactobacilli are microaerophilic which means they grow in the presence of reduced amounts of oxygen

v) **Nutrients:** All bacteria require a source of nutrients for metabolism. The fermenters require carbohydrates, either simple sugars such as glucose and fructose or complex ones such as starch or cellulose. The energy requirements of microbes are very high. Limiting the amount of substrate available can reduce the rate of fermentation.

4. Filling

Heated pickles are hot-filled (above 80°C) into clean sterile glass jars. The jars should be warm to prevent them cracking. If polythene pouches are used, the pickle should be cooled to room temperature before filling. Femented pickles are filled into clean, sterile jars or containers. Since these pickles are not further processed, it is important to ensure good hygiene during filling. It is important to ensure that there are no air bubbles trapped in the pickle during filling. A layer of good quality vegetable oil should be poured on the top of fermented pickles. This acts as a seal and helps to prolong the shelf life.

5. Add Salt or Brine

For pickling, any type of common salt is suitable as long as it is pure. Salt that contains chemicals to reduce caking should be avoided as the chemicals will make the brine cloudy. Salt with lime impurities can reduce the acidity and shelf life of the product. Salt with iron impurities can cause blackening of the vegetables. Salt with magnesium gives a bitter taste to the pickles. Salt containing carbonates can result in pickles with a soft texture. (Ref. Lal et al, 1986) Salt provides a suitable environment for lactic acid bacteria to grow. The lactic acid that they produce gives the pickle the characteristic flavour and preserves the vegetables. Salt can either be added to the vegetables as dry salt or made into a brine that the vegetables are soaked in.

a) **Dry salted pickles:** The salt extracts juice from the vegetables and creates a brine. For every 100kg of vegetables 3kg of salt is needed. Alternate layers of vegetables (about 2.5cm deep) and salt are placed in the fermentation container until it is about three

quarters full. The contents are covered with a cloth that is weighted down to help with the formation of brine. As soon as the brine is formed, fermentation starts and bubbles of carbon dioxide gas appear.

b) **Brine pickles:** Brine is used for vegetables that are naturally low in water. A 15-20% salt solution is prepared by dissolving salt in water. Vegetables are submerged in the brine using weights to hold them under the solution and the container is sealed. The strong brine draws sugar and water out of the vegetables, which decreases the salt concentration of the brine. It is important that the salt concentration does not fall below 12% as fermentation will not be able to take place. Extra salt is added periodically to maintain the strength of brine.

Added Spices and oils

a) **Spices:** Spices used should be good quality, clean and free of mould and insects. They are either roasted or fried before adding to the pickle mixture. The amount and type of spices added depends on personal taste.

b) **Starter culture:** Starter cultures are used to speed up the fermentation and to ensure consistency between different batches of pickle. Because they are acidic, the starter cultures inhibit the growth of undesirable organisms. It is possible to use fermented pickle juice that has been saved from a previous fermentation as the starter culture. It is important to ensure that the acidity of the starter juice is not too acidic as this will inhibit the activity of the Leuconostoc bacteria. Starter cultures of Lactobacillus species can be purchased from ingredient suppliers, but they may not be readily available in all countries.

c) **Oil:** Vegetable oil is added to the pickle. It is often mixed with the spices to make a paste. Oil is also poured onto the top of pickles to form a barrier against oxygen. Top quality vegetable oil should be used.

6. Packaging

Clean glass jars with lids are the preferred type of packaging for pickles. Small quantities of pickles can be packaged in polythene pouches that are sealed with a heat sealer. These pickles tend to have a shorter shelf life.

General

All equipment must be thoroughly cleaned each day to prevent contamination by insects and micro-organisms.

FSSAI

Standards & Guidelines

2.3.43: Pickles

- Pickles means the preparation made from fruits or vegetables or other edible plant material including mushrooms free from insect damage or fungal infection, singly or in combination preserved in salt, acid, sugar or any combination of the three.
- The pickle may contain onion, garlic, ginger, sugar jaggery, edible vegetable oil, green or red chillies, spices, spice extracts/oil, limejuice, vinegar/ acetic acid, citric acid, dry fruits and nuts.
- It shall be free from copper, mineral acid, alum, synthetic colours and shall show no sign of fermentation.

2.3.43: Pickles

- Pickles may be of combinations as given below:—

(i) Pickles in Citrus juice or Brine conforming to the following requirements:

(a) Drained Weight Not less than 60.0 percent

(b) Sodium Chloride content when packed in Brine Not less than 12.0 percent

(c) Acidity as Citric Acid when packed In Citrus Juice Not less than 1.2 percent

(ii) Pickles in Oil

(a) Drained Weight Not less than 60.0 percent

(b) Fruit and Vegetable pieces shall be practically remaining submerged in oil

(iii) Pickles in Vinegar

(a) Drained Weight Not less than 60.0 percent

(b) Acidity of vinegar as acetic acid Not less than 2.0 percent

(iv) Pickle without medium means the pickles other than enumerated above. This may contain ingredients given in Para 1 of this specification. Such pickles shall be labelled as "(give name of vegetable or fruits) Pickle".

The product may contain food additives permitted in FSSR 2011 regulations Appendix A

Acidifying agents singly or in combination	Acetic acid Citric acid Malic acid	GMP GMP GMP
Firming agents (singly or in combination)	Calcium chloride Calcium lactate Calcium gluconate Calcium carbonate Calcium bisulphite	350 ppm max. 350 ppm max. 350 ppm max. 350 ppm max. 350 ppm max.
Preservatives (Singly or in combination) & its Salt	Sulphur dioxide Benzoic acid and its sodium potassium or both	100 ppm 250 ppm

FSSR 2011 regulations Appendix B

Microbiological requirements

Mould Count	**Absent in 25 gm / ml**