

# PICKLES





## Fruit processing toolkit



# PICKLES

## 1.- General information



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.

## 2.- Examples

### Examples of different types of pickles.

Reference: Fellows (1997)

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.

## 3.- Processing Details

### 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.

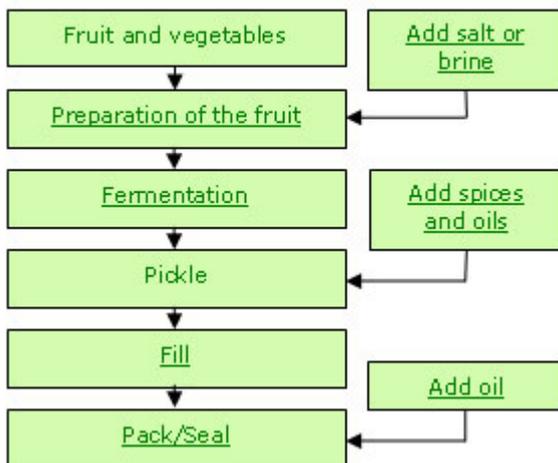
The conditions for fermentation (temperature, pH and salt content) need to be closely monitored to ensure a good product.

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.

### 3.1.-Fermented pickles

#### - Fermented Pickles -



#### A.-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.

#### B.-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 are 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.



### **C.- 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. Fermented 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.

### **D.- Add Salt**

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.

#### **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.

#### **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.

## E.-Added Ingredients

### - 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.

### - 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.

### - 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.

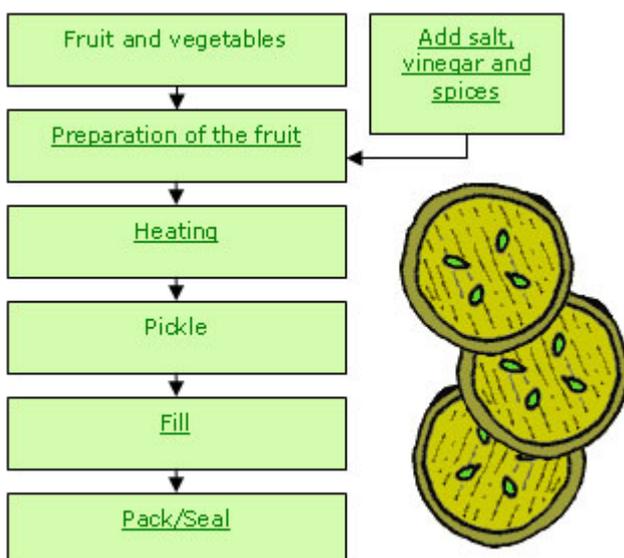
## F.-Packaging

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.

### 3.2.-Non-Fermented pickles



## **A.-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.

## **B.-Heat Treatment**

Fermented pickles are not usually heat treated. This stage of the process is for pickles made with acetic acid.

A stainless steel pan, preferably a double-jacketed pan, should be used for boiling. The pickle should be stirred during boiling to prevent burning.

The mixture of fruit, spices and vinegar is boiled until sufficiently thick and concentrated. Some pickles may be pasteurised in the jar after preparation to prevent spoilage.

## **C.-Filling**

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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.

### **E.-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.

## **4.- 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.

## 5.- Factors

### 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.

#### A.-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.

#### B.-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.

### C.-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.

### D.-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.

### E.-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.

## 6.- Basic pickles recipes

The following recipes are guidelines for production. The ingredients can be adjusted to suit local taste and seasonal availability of vegetables and fruit.



### A.-Tamarind pickle

**Reference: Fellows, 1997**

1kg fresh mature tamarind fruits

1kg sugar

For each kg tamarind:

40g coriander

50g cumin

30g black cumin

3-4 cloves

3-4 cardamoms

3-4 pieces of cinnamon

10-12 chillies

30g salt

250ml mustard oil

15g caraway seeds

30g pepper

1. Select fresh, mature but unripe tamarind fruits. Discard over-ripe fruits and any with disease or infection.

2. Wash fruit well in clean water. Soak in clean water for 12 hours then strain.

3. For each 1kg tamarind add 1kg sugar. Boil in a stainless steel pan, stirring continuously until the mixture thickens.

4. Fry the spice mixture then grind to make a paste. Add the spice mix to the tamarind and mix thoroughly.

5. Hot-fill the mixture (above 80°C) into sterilised glass jars or cold fill into plastic bags. Make sure there are no air bubble trapped in the pickle. Pour a small amount of oil over the top.

## **B.-Olive Pickle**

**Reference: Fellows, 1997**

1kg olives

30g turmeric

400g sugar

250ml mustard oil

40g ground ginger

50g coriander

30g garlic powder

250ml vinegar

40g mustard seed

50g mixed spice

1. Mix the turmeric with the olives and dry in the sun for 3-4 days.

2. Grind the spices with the vinegar and fry in the hot oil.
3. Mix the fried spices with the olives and boil, stirring continuously, until the mixture thickens.
4. Add the sugar and stir until it is all dissolved.
5. Hot-fill the pickle into clean, sterilised glass jars. Ensure that all air bubbles are removed and that there is a layer of oil on top of the pickle.

### C.-Mango pickle

Reference: Fellows, 1997

20kg mature mango

3.5-4kg salt

200g turmeric

400-800g mustard seed, lightly roasted

400-800g fenugreek seed, lightly roasted

400g-1kg chilli powder

roasted asafoetida to taste

2-2.5kg vegetable oil

Other spices including mace, cumin, garlic, mint, aniseed, ginger, coriander, cloves, cardamom and pepper can be used according to local tastes.

1. Select fresh, mature but unripe fruits. The best varieties to use are those with an acidic taste. Discard ripe, damaged or mouldy fruits.
2. Wash the fruit in clean water. Remove the stones and slice the flesh into uniform sized pieces.
3. Hold the fruit pieces in a 2-3% salt solution to prevent browning of the surfaces.
4. Use 3.5-4 kg salt and 200g turmeric per 20kg mango. Mix the turmeric with the mango. Place alternate layers of mango with salt in a sterilised container with a lid. Cover the fruit and weight it down.
5. Place the covered jar in a warm place (in the sun) to ferment for 4-5 days. The salt dissolves to form a brine. Ensure that the fruits are covered with the brine. The mango pieces become pale yellow.
6. Mix the roasted spices with the oil. The choice of spices depends on local taste.
7. Pack the pickle into clean, sterile glass jars. Ensure there is a layer of oil on top of the jar.
8. Store the pickle in a cool place away from direct sunlight.

## D.-Lime Pickle

Reference: Fellows, 1997

Lime pickle is made from salted pieces of lime packed in a salty, spicy liquor. It is brownish red and the lime peels are yellow or pale green with a sour and salty taste. It is eaten as a condiment with curries and other meals. If processed well the product can be stored for several months.

5kg limes

1kg salt

5g turmeric powder

150g chilli powder

100g fenugreek seeds

100g mustard seeds

1. Select ripe but not over-ripe limes with dark yellow skins and no sign of bruising or mould growth.
2. Wash the limes in clean water and dip in hot water (60-65°C) for about 5 minutes to soften the skin.
3. Cut each lime into four pieces and dip into a saturated salt solution for 20-30 minutes. Alternatively, pack the limes and salt in layers (1kg salt per 5kg limes) in a sealed jar, ensuring that the surface is covered with juice. Ferment the packed limes for 24 hours. It may be necessary to press the fruits down to hold them under the surface of the liquid.
4. Dry in the sun for 2-3 days. Sometimes salt crystals are sprinkled on the limes while they are drying. Drying is continued until the skin becomes brown and the pieces are soft and breakable.
5. Roast the fenugreek seeds until they splutter. Grind all the seeds together and add to the limes.
6. Fill into pots or glass jars and seal.
7. Store in a cool place away from direct sunlight. Store for one month to allow fermentation to take place.
8. Re-pack in sterilised glass jars or polythene bags, ensuring that no air bubbles are trapped in the pickle. Pour a thin layer of oil onto the surface of the pickle.
9. Store in a cool place away from sunlight.

## E.-Pickled Cucumbers

Reference: Battcock and Azam-Ali, 1998

20kg small cucumbers or 15kg large cucumbers

1kg salt

Cucumbers are fermented by lactic acid bacteria to make a dark green, slightly transparent product. Occasionally oil is added to the fermented product.

1. Select ripe cucumbers that are free from bruising or disease.
2. Wash in clean cold water and drain.
3. The cucumbers can either be pickled whole or sliced. If slicing, cut into 5-8cm pieces.
4. Place cucumbers and salt (1kg salt per 15-20kg cucumber) in alternate layers in a sealed container. A brine forms to cover the cucumbers. Ensure that they are submerged in the brine. If the brine is not sufficient to cover the cucumbers, prepare a 40° Salometer brine and add it to the pot.
5. As soon as the brine is formed fermentation starts. Bubbles of carbon dioxide gas appear. Leave to ferment for 1-4 weeks depending upon the temperature. Fermentation is complete when no more bubbles appear.
6. Pack into clean sterile jars and close with lids. Store in a cool place. Sometimes a layer of oil is added to the top of the pickle.

## **F.-Atchar nectar**

**Reference: Azam-Ali et al, 2003**

750g carrots

600g cabbage

100g capsicum

450g onions

120g cayenne pepper

15g ginger powder

40g salt

30g curry powder

750ml sunflower oil

300ml vinegar

Atchar is a hot and spicy non-fermented vegetable pickle that is common in Asia. Variations can be made by using different vegetables according to local taste and availability.

1. Sort the fruit and vegetables, discard any unripe, over-ripe or damaged ones.
2. Wash and peel the vegetables. Chop into small pieces of a uniform size.
3. Lightly cook the vegetables for about 5 minutes and mix with soft-fried onions and a blend of spices, salt and vinegar.
4. Heat for a further 5 minutes with stirring.

5. The salt and vinegar act as preservatives. It is essential that the ratio of these two ingredients is controlled to prevent spoilage during storage. The final level of acetic acid should be 6-10%.

6. Hot-fill into clean sterile jars. Seal with a lid and cool to room temperature.