

Pre-Feasibility Study

Pickles Industry

December 2021



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It is important to mention that data in the sub-sectors of the agri-food industry is sometimes scarce largely due to the fact that a significant number of companies and individuals operate partly or fully in the informal sector.

PREFACE

As part of the United Nations' Productive Sectors Development Program (PSDP) in Lebanon, which aims at supporting gender-responsive job creation and economic opportunities in the agri-food sector, the United Nations Industrial Development Organization (UNIDO) is committed to reduce the gap in market intelligence for micro, small, and medium enterprises (MSMEs) in the agri-food sector, as well as to support the Ministry of Industry in terms of institutional capacity.

As such, UNIDO, in cooperation with the Ministry of Industry, is drafting several product-specific pre-feasibility studies that provide MSMEs – in key value chains in the agri-food sector – with information and insights that could help them improve their production process, make it more efficient, and raise awareness on international standards that would enable them to export their products abroad. Through these reports, UNIDO also provides institutional support to the Ministry of Industry in finding and gathering data, and in turn transforming it into actionable insights, so that it efficiently promotes Lebanese agri-food products.

Furthermore, this report comprises research insights and growth opportunities in the pickle industry within the Lebanese market, while focusing on its potential to become more competitive and prominent. In addition, several consultations have been conducted with industry experts and major players, in order to provide tangible product knowledge for Lebanese producers.

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DEFINITION OF PICKLED PRODUCTS

Pickled products comprise mainly a blend of vegetables and/or fruits conserved in a mixture consisting of an acidic solution (with a reduced pH), added salt and spices, as well as other liquids (FAO). The two main methods used for pickles preparation are based on lactic acid fermentation – whether the vegetables are salted or not – which results in two distinguished products with different savour and texture. Both fruits and vegetables can be conserved in a high salt solution for months before finally processing them into pickles in other seasons. Nevertheless, since the fermentation of the products doesn't include heating, thus, it requires a stern consideration of hygiene practices.

The lactic acid bacteria used in the fermentation of pickled vegetables such as carrots, cauliflowers, and cucumbers brews sugars to generate lactic acid, which in turn prevents the development of toxic bacteria or fungi. However, in order to be efficient, the bacteria should grow in a low concentration of salt. Therefore, the added salt is considered a major component since it impacts the form and level of fermentation: 2% to 5% of salt will produce pickles which have a high level of acidity, while higher levels up to 16% will induce salt-stock pickles or pickles in high salt concentration. In spite of everything, monitoring the level of pH, salt, and temperature is crucial to keep away any unwanted bacteria. Sugar is also one of the materials that could be added to increase the degree of fermentation or to sweeten the pickled product.

Table 1: Examples of different types of pickles

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

Source: FAO, Food Processing Toolkit, Pickles

¹FAO, Fruit Processing Toolkit, Pickles

In Lebanon, pickles are part of the traditional and typical table available in almost every Lebanese household. Pickled products, mainly cucumber pickles, are usually added to appetizers or main dishes, and can even be included as an accompaniment to the daily meal.

Pickled products are available in supermarkets under different local and foreign food brands, or could even be made at home as part of the “Mouneh” tradition by Lebanese families.

Below are some of the pickled products sold in Lebanese supermarkets (non-exhaustive):



Almond



Beetroot



Cauliflower



Ginger



Eggplants



Turnip



Onions



Gherkins



Cucumber



Jalapeno



Wilde Thyme



Mekti



Olives



Cabbage

MACRO TRENDS

I. Market Size – Global, Regional, and Local

- The global demand for pickles has been on the rise over the past two decades, driven mainly by evolving consumer preferences, cuisines, and recipes. This trend is reflected by the increased number of product launches in pickled products by multinational firms. Data on trade flows also suggest a rise in the demand for pickles. In this context, global imports of pickled products grew by a compounded annual growth rate (CAGR) of 6% from \$751.6m in 2001 to \$2.3bn in 2020².
- As pickled products are part of Lebanon's cuisine and its traditional "Mouneh" products, they are in high demand locally, as well as by the Lebanese diaspora worldwide, which is mainly due to the fact that the Lebanese consumer preferences are geared towards Lebanese pickles more than imported ones. The market for pickles was estimated at more than \$30m in 2016³, with about 67% of the latter being exported abroad.
- Given that pickled products go well with the Lebanese "Mezze", they are demanded significantly at Lebanese restaurants and consumed at home as a complement to main dishes or as an "Amuse-Bouche".

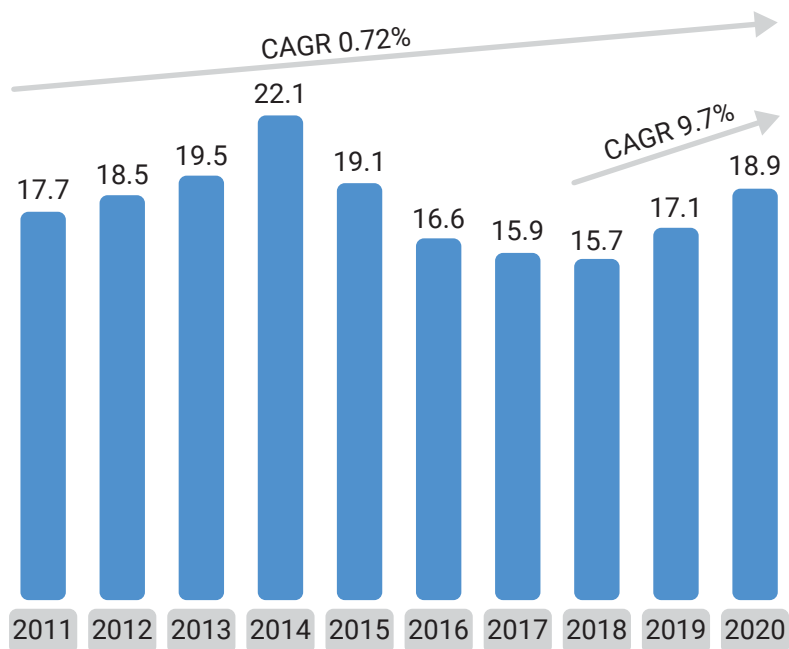
II. Trade Performance

- Lebanese exports of pickled products (HS code 2001) have been volatile over the past 10 years, as they grew from a total of \$17.7m in 2011 to a peak of \$22.1m in 2014, before declining to \$15.7m in 2018 (figure 1). However, they increased to \$18.9m in 2020, posting a CAGR of 9.7% between 2018 and 2020. As such, despite their volatility, they have grown by a CAGR of 0.72% between 2011 and 2020, relative to a global CAGR of 2.1%. In comparison, exported pickled products from Lebanon posted a CAGR of 16% between 2001 and 2011, exceeding the growth in global exported pickles at 10.2% during the same period.

²ITC Trade Map

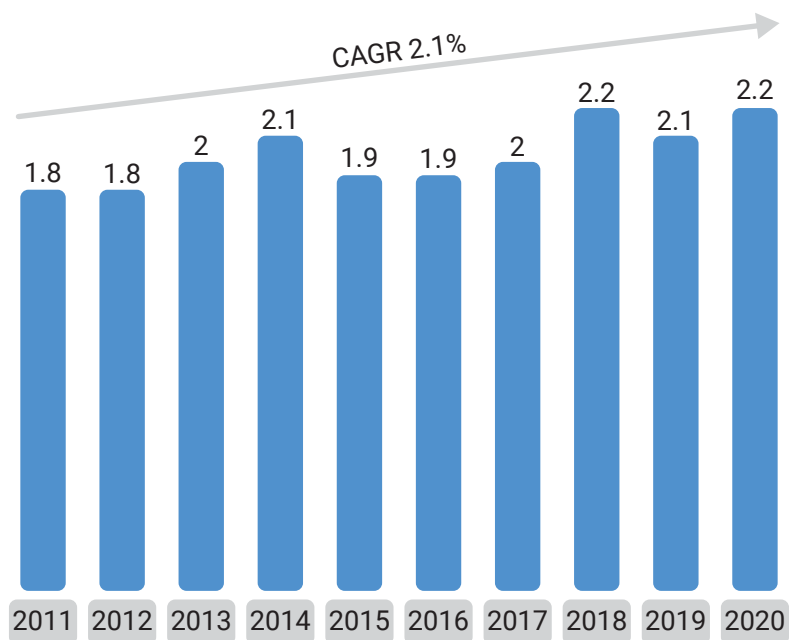
³The Ferment of Expansion, USAID

Figure 1: Exports of pickled products in \$US Million (2011-2020)



Source: Lebanese Customs

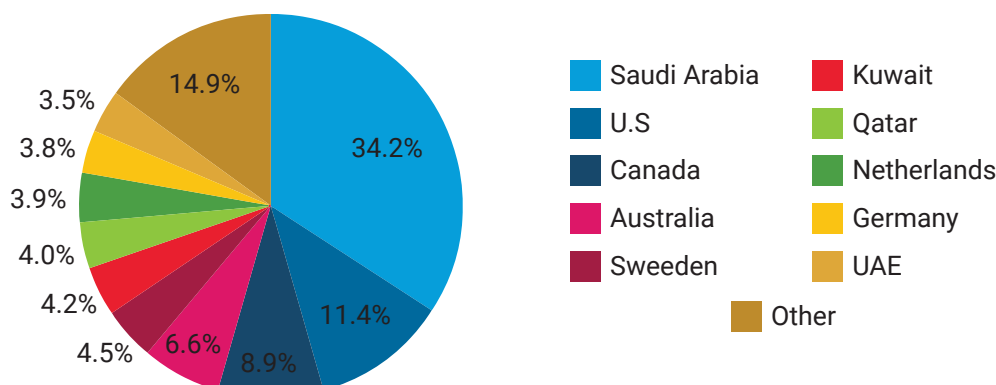
Figure 2: World Exports of Pickled Products in \$US billion (2011-2020)



Source: ITC Trade Map

- Pickled cucumbers and gherkins (HS code 2001.10) represented 14.7% of the total exports of pickled products in 2020, olives prepared or preserved by vinegar or acetic acid (HS code 2001.90.10) accounted for 5.4% of total exports of pickled products, whereas other pickled products (HS code 2001.90.90) were equivalent to 79.4% of exported pickles – which include mixed types of pickles among others⁴.
- In 2020 Lebanon exported \$18.9m of pickled products, with \$6.5m or 34.2% to Saudi Arabia, \$2.2m to the U.S. (11.4%), \$1.7m to Canada (8.9%), and \$1.3m to Australia (6.6%), among other countries (figure 3).

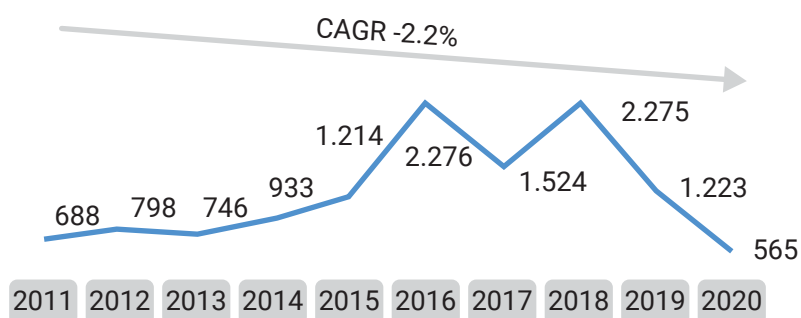
Figure 3: Main export markets of Lebanese pickled products in % (2020)



Source: Lebanese Customs

- Imports of pickled products registered a CAGR of -2.2% between 2011 and 2020, reaching \$0.57m⁵. However, imports of pickled products showed a significant growth between 2011 and 2016, increasing from \$0.69m in 2011 to \$2.3m in 2016, but they dropped drastically from \$2.3m in 2018 to \$0.57m in 2020 (figure 4). The recent decline in imported pickles shows a potential for replacing the latter with local pickled products, given the decline in the local purchasing power, as well as the good quality of locally-produced pickles.

Figure 4: Imports of Pickled Products in US\$ thousand (2011-2020)



Source: Lebanese Customs

⁴Lebanese Customs

⁵Lebanese Customs

- Most of the imports of pickled products in 2019 were from China, the U.S., Morocco, Japan, France, Mexico, and Turkey; however, the main sources of imported pickles in 2020 were Syria, Turkey, France, China, Germany, Egypt, and the U.S.
- Overall, the trade balance of pickled products in Lebanon reached a surplus of \$18.3m in 2020 – its highest level since 2014 – which reflects a potential competitive advantage of locally produced pickles in the domestic market. In addition, the export and import figures of pickled products show that the industry is an important source of hard currency to the country, which is increasingly needed given the current economic and financial crises in Lebanon and the depreciation of the local currency.

III. Supply of pickles in Lebanon and the region

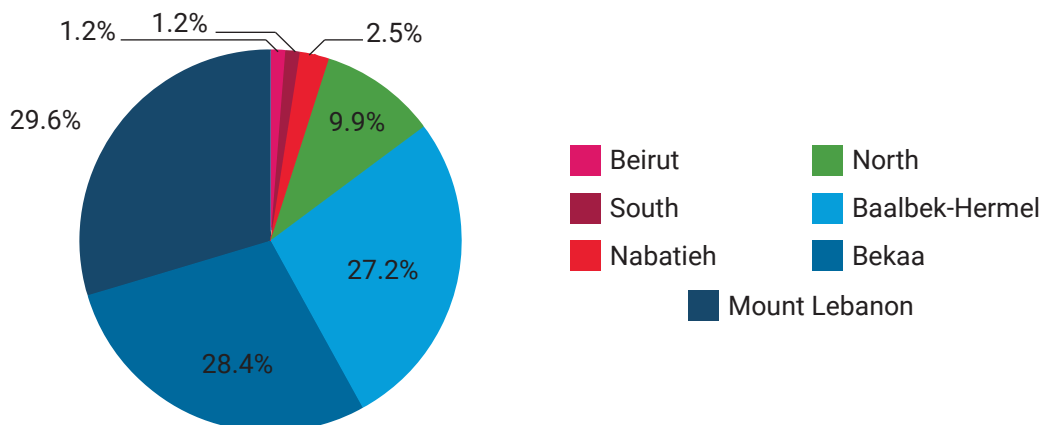
- According to the Ministry of Industry, there are 81 entities that produce pickled products in Lebanon. It is worth mentioning that several cooperatives that produce a wide variety of agri-food products are also involved in the production of pickles. In addition, many households prepare their own pickled vegetables, which make up a large segment of homemade pickles in the country. Moreover, it is important to mention that pickles complement many main meals and are considered part of the region's culinary traditions.
- Pickled turnips are the most popular type of pickles in Lebanon, along with gherkins, olives, eggplants / stuffed eggplants, carrots, cauliflowers, hot peppers, garlic, onions, mixed vegetables, among others.
- Despite the relatively significant number of producers, about 85% of pickles are produced by eight pickling food processors in Lebanon⁶.
- The concentration of pickling companies are located in the Bekaa, Mount Lebanon, and the North, mainly due to the fact that vegetable crops are grown in the coastal plains, Bekaa valley, and medium-elevation mountains.⁷ In addition, this is due to the traditional way of preparing the Lebanese “Mouneh”, where typically villagers used to preserve their own local crops and foods, mainly at the end of summer and beginning of autumn season⁸ (Figure 5).

⁶The Ferment of Expansion, USAID

⁷Lebanon: Second Report on The State of Plant Genetic Resources for Food and Agriculture, FAO

⁸Overview on Local Agriculture and Food Heritage: Case of West Bekaa and Shouf in Lebanon, MedSNAIL

Figure 5: Pickles Producers by Region (% 2021)



Source: Ministry of Industry

- Over the past few years, big producers have been investing in the field by expanding their businesses and buying fermentation tanks, which has in turn reduced operating costs and production losses.
- More and more pickle producers have been investing in E-commerce, since these products are significantly demanded by the Lebanese diaspora worldwide, which in turn makes it easier to engage with customers.

Neighboring countries with large exports of pickles:

- Several countries are known for specific types of pickles, for instance Mango pickles are known in India, Cornichon pickles are considered a French specialty, and Giardiniera pickles (a mix of carrots, cauliflower, onions, peppers, and zucchini) are known as an Italian preserve.
- Pickle production is a main agri-food industry in several Mediterranean countries. Additionally, a lot of the vegetables used for pickling in the region are the same, hence leading to similar pickled products.
- In 2020, there were different high-export pickle producers that were relatively close to Lebanon, for example Turkey with exports of \$293.8m, Greece (\$111.7m), Spain (\$90.8m), Egypt (\$59.1m), Italy (\$41.6m), and North Macedonia (\$18.2m)⁹.

⁹ITC Trade Map

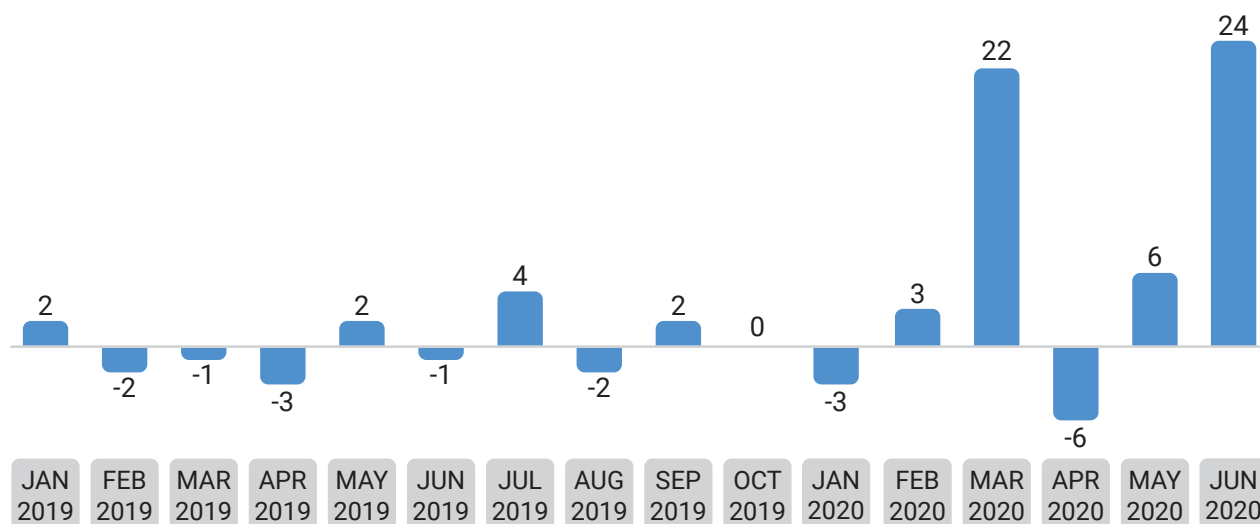
- Cucumbers and gherkins represented about 43.7% of Turkey's exports of pickled products in 2020, while exports of pickled capsicum and sweet peppers each accounted for about 19% of the pickled products¹⁰. Turkey also exported pickled olives, onions, beetroot, and other types with Germany, the Netherlands, the U.S., the UK, Switzerland, Australia, and Romania being its main markets.
- As for Greece, pickled olives and genus capsicum (excluding sweet peppers and pimentos) were its main pickled exports, followed by sweet peppers. Its main markets were Germany, the U.S., the UK, Netherlands, Belgium, and France.
- Egypt's main pickled exports included sweet potatoes and similar products, as well as cucumber and gherkins, among others. The main markets for Egypt's pickled exports were the U.S., Germany, Iraq, the UAE, Libya, Pakistan, and Saudi Arabia.
- As such, cucumbers, olives, genus capsicum, sweet peppers, sweet potatoes, and mushrooms tend to be the most exported types of pickles across the Middle East & North Africa (MENA) region as well as the Mediterranean region. Most of these types of vegetables are cultivated in Lebanon, which shows a large potential for raising Lebanese exports of pickles, and providing competitive substitutes for foreign markets.

IV. Prices of Pickled products in Lebanon

- As the economic and financial crisis started to unfold, especially since October 2019, the Lebanese pound has significantly depreciated, which in turn has raised the inflation rate in Lebanon. In addition, the COVID-19 lockdown measures led to a spending spree in the grocery stores across Lebanon, since many individuals feared that some products would become unavailable or more expensive, given the depreciation of the Lebanese pound and the closure of many different businesses. Consequently, the prices of pickles rose significantly in Lebanese pounds in 2020, especially month-on-month in March and June 2020, as shown in figure 6.

¹⁰ITC Trade Map

Figure 6: Growth in prices of pickled products in percentage (month-on-month)



Source: Ministry of Economy & Trade

- However, the depreciation of the Lebanese pound has made Lebanese products more competitive in international markets, despite the inflation. As such, Lebanese pickles, which are known for their good quality, could gain competitiveness compared to other producers in the Mediterranean region.

MEANS OF PRODUCTION

I. Machinery needed

The production of pickles has become more automated in large companies, whereas small factories still rely on labor force. The following machines are deployed once the processing phase begins in order to maintain consistency, uniformity, and quality standards in the final product:

- **Washing machine:** The objective is to clean inputs of dirt and any residuals that might be present on their skin. Two main types of washing machines are used:
 - The first uses a simple washing line in which the vegetables pass under pressurized water faucets to be cleaned.
 - The second uses a bubble cleaning machine which adopts the high-pressure water and bubbles to scatter, tumble, and clean the vegetables. The materials are then transferred and washed by a spraying cleaner again.
- **Cutting Machine:** depending on the type of pickles produced, the machine slices the pickles to one unique size and shape such as chips, cubes, and others. It's crucial to maintain a clean environment to avoid contamination.
- **Sorting Machine:** used to categorize and then filter vegetables for the processing stage; large ones are excluded and put away, as for the others they are sorted between small and medium sizes.
- **Filling Machine:** First the pickle liquid is mixed in a container and then filled in jars containing the sliced fruits/vegetables. The liquid is traditionally made of a mixture of vinegar, salt, and other ingredients depending on the type.
- **Packing Machine:** the packing machine brings the exact quantity of fruits/vegetables to each jar, and then transfers them to the filling machine. After the labeling, the filled jars are also moved along the packing machine to put them in their respective boxes.
- **Labelling Machine:** Once the jars are ready, they are moved to the labelling machine, which will automatically attach the labels that include the expiry date, list of ingredients, brand name, and product description.

- Pasteurizing Machine: The process of pasteurization occurs when heat is applied to a food product in order to:
 - Destroy pathogenic (disease-producing) microorganisms that will lead to product contamination.
 - Inactivate spoilage-causing enzymes and reduce or destroy spoilage microorganisms.

Moreover, the relatively mild heat treatment used in the pasteurization process is proven to cause minimal changes in the sensory and nutritional characteristics of foods compared to the severe heat treatments used in the sterilization process.

- Cooling: Usually pickles are not cooled but kept at room temperatures. However, it is recommended to refrigerate pickles after opening the jar or container for the first time.

Note

Washing, filling into jars, preparation and adding of brine, and capping could be done manually as long as the product is clean and uncontaminated.

In terms of equipment, there are the traditional barrels usually made of oak wood or the newly adopted food graded plastic barrels made from robust materials such as fiberglass or cross-linked polyethylene. The lids of the barrels should be perforated to allow the brine to pass through and to keep the buoyant cucumbers submerged. Such barrels can vary between 1,000 and 10,000 liters in capacity. Such large barrels (10,000L) were recently introduced to the Lebanese market through the assistance of USAID through the Lebanon Industry Value Chain Development program. This thorough change in the pickle industry had a thumping impact on the production capacities and quality. Furthermore, the project aimed at streamlining and fostering the local sector by supporting industries and introducing them to numerous techniques that were implemented for the first time in Lebanon, such as introducing an optical sorting machine to the production line as well as the idea of brine recycling, which directly impacts the cost of production.

II. Labor force

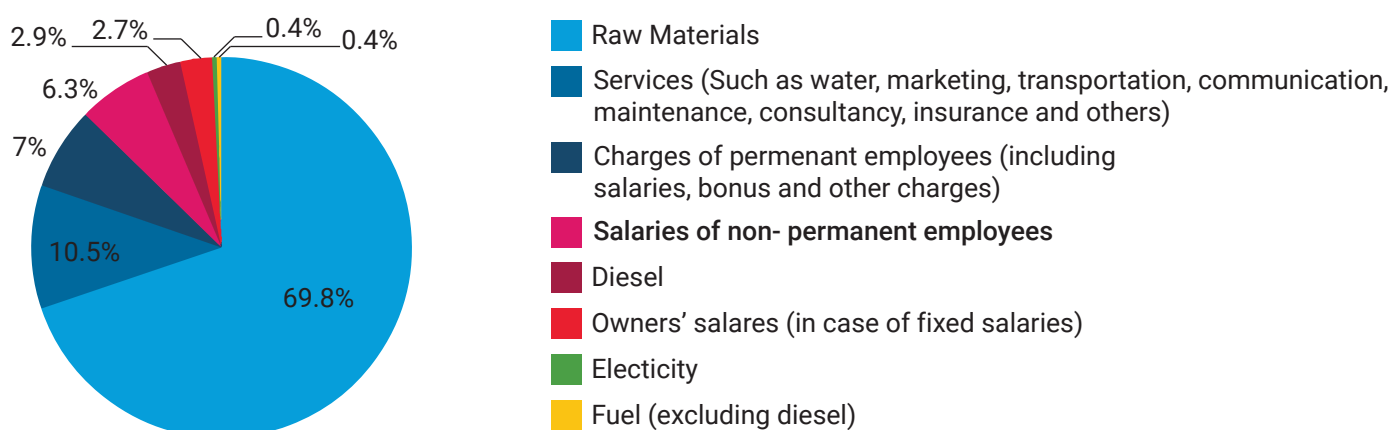
Qualified labor force: As per the Ministry of Industry decision No. 8676/2020, all agri-food companies and slaughterhouses are required to have a food safety specialist that will handle the direct and permanent supervision of the production process inside the factory, including production methods and quality of products, starting with the entry of raw materials into the factory and ending with the final product. This could be leveraged by the employment of a food safety team including a production manager, quality assurance officer(s), quality control officer(s), and a food safety specialist.

Others: including workers for washing, sorting, and cutting the vegetables/fruits and filling, packaging, and labelling the final product. The majority of these employees could be potentially replaced by machines; thus, the range of labor force involved in the processing phase will vary depending on the level of automation in the industry.

III. Average cost breakdown

Based on a sample of 4 pickle industries, figures show that the highest production cost is allocated to raw materials (69.8%), followed by services (10.5%), salaries and charges of permanent (7%) and non-permanent employees (6.3%) and other expenses (figure 7).

Figure 7: Average cost breakdown of the pickle industry in % (2017)



Source: Ministry of Industry, 2017

IV. Quality requirements for raw material inputs

Vegetables are highly nutritious and perishable foods that have very short shelf life. Preservation of these important foods has been practiced for a long time using various methods. Pickling is a traditional process that preserves vegetables and fruits through anaerobic fermentation or acidification with vinegar (Hassan and Sarfraz 2018), resulting in fermented products being regularly consumed in most societies throughout the world.

Recently many technologies have been developed for vegetable pickling. The main process used in vegetable pickling relies on a microorganism biological activity that produces metabolites with the ability to suppress the growth of many contaminating and undesirable microorganisms.

Based on the preparation method and ingredients used, pickled products are classified into two general classes:

1. Fermented or brined pickles, which are cured for several weeks during which fermentative bacteria produce acids thereby lowering the pH level and consequently preserving the products
2. Fresh pack or quick process pickles, which are simply vegetables that are packed in jars, covered with vinegar and other flavorings and then pasteurized by heat (Washer et al. 2010)

The market for preserved vegetable products is dominated by the acidified, fermented, and non-fermented pickles (Fleming et al. 1995).

Raw materials used in pickles:

There are six basic types of ingredients used for making pickles. The main ingredient is the different type of food that will be used in the pickling process. The additional ingredients include acids or brine, flavorings, colorants, preservatives, and stabilizers that make up the liquid (or liquor) in which the pickle is sold.

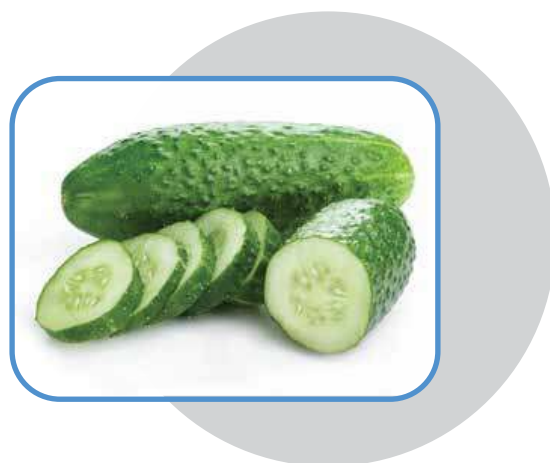
I. Inputs

1. Cucumbers

Both wild (*Cucumis anguria*) and domesticated species (*Cucumis sativus*) can be used to produce cucumbers and gherkins.

There are specific varieties and seeds used for producing cucumber that will turn into pickles and gherkins, The varieties are:

- Bush Pickles
- Corentine Hybrid
- Early Russian Cucumber
- Fancipak Hybrid
- Jackson Classic Hybrid
- Puccini Hybrid
- Pioneer Hybrid
- National Pickling
- Sassy Hybrid
- Armenian cucumbers



In Lebanon some of these varieties are present under different commercial names and companies:

Table 1: Examples of different types of pickles

Company	Variety
Debbaneh	Fiesty F1 Cross Country F1
Robinson Agri	Bejo Artist
Unifer	Maresa Mirabelle Mandy Monisia
Janat Al Bekaa	Ajax Platina Sanita
Agricultural Material Company	Baraka Outa

Source: FAO, Food Processing Toolkit, Pickles

Furthermore, there are some general requirements that one should look for while picking ideal cucumbers for pickling:

- **Peel color:** The color of the vegetables is determined by the type and age. For blanks, choose vegetables that are dark green in color. Do not use cucumbers that have ripened and have a yellowish peel for such purposes. It is rude and very hard.
- **Spines and bumps:** Spikes cucumbers have a black or white color. For blanks, it is recommended to use cucumbers with dark thorns; they perfectly pass the brine. However, the varieties with white thorns are usually used for salads. In other words, if they are used for canning, they will not be crisp, because the thick skin does not absorb the brine properly.
- **The size of each cucumber:** Cucumbers that are more than 10 cm in length are not recommended for use in canning. Small cucumbers are easier to place in the bank; they look attractive.
- **The quality of the peel:** For blanks, make sure not to take vegetables that have a skin that is too thin, since they will not crunch. It is best to use cucumbers that have a skin that is difficult to peel with a fingernail.
- **The flesh:** It should be dense, while the seed chamber should make up no more than 20% of the whole cucumber.

Note

In Lebanon, Armenian cucumbers, locally known as Mekteh, are widely known and highly consumed with some of the most traditional plates of the Lebanese cuisine (Hummus – Falafel – Moghrabiya – Foul moudames), and they are considered as part of the “Mouneh” products.

One of the most important criteria of Armenian cucumbers is being an open pollinated crop, enabling farmers to save seeds from season to season.

2. Makdous

Makdous is a traditional dish of oil-cured eggplant. It is part of the Iraqi and Levantine cuisine (Jordan, Lebanon, Palestine, Israel, and Syria). They are usually done with baby vegetables (eggplants or green beans) and are stuffed with walnuts, red pepper, garlic, olive oil, and salt. Sometimes chili powder is added.



The main vegetables used for the Lebanese Makdous are:

- Baby eggplants (both varieties are used):
 - Japanese Eggplant (known for their black and purple color)
 - Graffiti Eggplant (known for their purple and white color)
- Baby green beans:
 - Bush beans and French beans are mainly used



3. Mixed pickles

Mixed pickles use a wide range of local varieties of cucumbers, carrots, cauliflowers, onions, and turnips fermented and preserved together.



4. Turnip pickles

Just like Mekteh, pickled turnip (also labeled the pickle of the Middle East) is highly demanded and consumed and is very common and considered an important side dish to many of the traditional Lebanese cuisine plates and sandwiches such as (Hummus – Falafel – Moghrabiyyi – Foul moudames – Shawarma and more).

Pickle turnips get their gorgeous hue from hanging out with a handful of sliced beets. Like most pickles, turnips are pickled in vinegar and kept at room temperature whilst sealed. Once the jar is open, it is recommended to refrigerate it.



II. Acids and Brine

Acetic acid (vinegar) is the primary ingredient used in pickle manufacturing. After water, it makes up the bulk of the pickle liquor and contributes significantly to the flavor of the pickle, giving it a sour taste. Additionally, it also has a preservative effect and is nontoxic. Vinegar is derived from naturally occurring sugars or starches through a two-step fermentation process. Starch is converted to sugar, and then is fermented by the yeast to form alcohol. The alcohol is exposed to an aceto-bacteria, which converts it to vinegar. Vinegar can be obtained from many sources and each one has a slightly different taste. Therefore, depending on its source, the vinegar can have a significant effect on the taste of the final pickle product.

The ideal ratio to make an acid pickling solution is:

- **2.8 L of Acetic acid (5%) – 37% of the total amount of the solution**
- **3.8 L of water – 63% of the total amount of the solution**
- **24 g of salt per 1 liter**

Brine is a pickling liquid characterized by high concentration of salt (NaCl). As a matter of fact, immersing pickles in brine for a long period of time will result in anaerobic fermentation, which directly affects the pickles' texture and flavor. Mustard seeds, cinnamon, or cloves can also be added for flavoring.

Furthermore, while using brine, it is important to always keep in mind that besides our additives, different types of microorganisms play a role in the texture and the flavor of the end product depending on their dominance in the solution, which is governed by the following factors:

- Acidity of the solution
- Salinity of the solution
- Temperature of fermentation
- Exclusion of oxygen

The ideal ratio to make a brine pickling solution is:

- 950 ml of water
- 30 g of salt

III. Flavorings

Flavorings are focused on altering or enhancing the flavors of pickles. Most types of flavorants are focused on scent and taste. Few commercial products exist to stimulate the trigeminal senses, since these are sharp, astringent, and typically unpleasant flavors.

In pickling, flavoring is one of the most important stages where innovation can take place, since there is no rule or a defined method for flavoring, it all comes back to ingenuity and trials.



There is a wide range of products that can be used in flavoring including hot spices such as capsicum, black pepper, ginger, and mustard. Herbs like basil, marjoram, mint tarragon, and thyme are also used to give pickles a unique taste. Flavorful vegetables including onions and garlic are often included in pickle liquor.

IV. Preservatives

Preservation of food products, containing chemical food preservatives, is usually based on the combined or synergistic activity of several additives, intrinsic product parameters (e.g., composition, acidity, water activity), and extrinsic factors (e.g., processing temperature, storage atmosphere, and temperature).

Chemical food preservatives are applied to foods as direct additives during processing, or they develop on their own during processes such as fermentation. Certain preservatives have been used either accidentally or intentionally for centuries, and include sodium chloride (common salt), sugar, acids, alcohols, and components of smoke. In addition to preservation, these compounds contribute to the quality and identity of the products, and are applied through processing procedures such as salting, curing, fermentation, and smoking.

Food additives, which could be added to pickled vegetables, are mentioned in the following categories of the mandatory Lebanese standard NL 761:2016 (Food Additives) and its modifications / amendments:

- 4.2.2.3 Vegetables (including mushrooms and fungi, roots and tubers, pulses and legumes, and aloe vera) and seaweeds in vinegar, oil, brine, or soybean sauce
- 4.2.2.7 Fermented vegetables (including mushrooms and fungi, roots and tuber, pulses and legumes, and aloe vera) and seaweed products of food category 06.8.6 (fermented soybeans e.g. natto, tempe), 06.8.7 (fermented soybean curd), 12.9.1 (fermented soybean paste e.g. miso); 12.9.2.1 (fermented soybean sauce) and 12.9.2.3 (other soybean sauces)

Acetic acid: is a general preservative inhibiting many species of bacteria, yeasts, and to a lesser extent molds. It is also a product of the lactic-acid fermentation, and its preservative action, even at identical pH levels, is greater than that of lactic acid.

Potassium sorbate, a white fluffy powder, is very soluble in water (over 50%) and when added to acid foods, it is hydrolysed to the acid form. Sodium and calcium sorbates also have preservative activities; however, their application is limited compared to that of potassium salt, which is employed because of its stability, general ease of preparation, and water solubility.

Sodium benzoate is a common preservative in acid or acidified foods. Yeasts are inhibited by benzoate to a greater extent than are molds and bacteria.

V. Technical requirements for pickle production

Local food safety requirements for input material

Food safety requirements cover all the stages that a vegetable will undergo to transform into a pickle, from picking to canning.

Local requirements can be accessed under the Lebanese standard **NL 241:2018** (pickled fruits and vegetables) at **LIBNOR**.

The following section will highlight the general requirements for pickles:

In order to control the products' quality and safety for consumers, general norms for substrates are set for each type of pickling:

Pickles in citrus juice or brine conforming to the following requirements:

- **Minimum fill:**
The container should be well filled with the product (including packing medium when appropriate), which should occupy no less than 90% (minus any necessary head space according to good manufacturing practices) of the water capacity of the container. The water capacity of the container is the volume of distilled water at 20° C, which the sealed container will hold when completely filled.
- **Minimum Drained Weight:**
The drained weight of the product should not be less than the following percentages, calculated on the basis of the weight of distilled water at 20° C, which the sealed container will hold when completely filled:
 - a. Whole and Halves Style should not be less than 40% of the net weight
 - b. Pieces Style and Other Styles should not be less than 50% of the net weight (except for pickled red cabbage should not be less than 45% of the net weight)
- Sodium Chloride content in the packing medium should not exceed 10%
- Percentage of oil should not be less than 10% in the final product packed in edible oil
- Overall acidity should not be less than 0.5% and shall not exceed 3.5 %determined as acetic acid
- pH of packing medium should not be less than 4.6%

Detentions and Rejections

Detention occurs when products entering a country are refused entry by its Customs and Border Patrol, following international standards of food and safety. These detentions occur when there is reason to believe that the products do not conform to country laws and regulations.

Rejection often occurs when the product does not meet the general mandatory technical requirements for the country. Main reasons given for detention and rejection include:

- Noncompliance with labelling requirements
- Decomposition
- Insect and animal filth and damage
- Use of prohibited additives
- Heavy metal contamination
- Excessive levels of pesticide residues
- Excessive levels of mycotoxins
- Mold infestation
- Microbiological contamination
- Swollen and otherwise faulty cans

It also occurs when the products do not meet the general mandatory requirements such as pesticide's norms, packaging norms, and quality norms of the country. All producers should ensure that their products comply with these requirements or they run the very real risk of having them rejected, which will lead to considerable financial loss for the producer.

Good manufacturing practices (GMP) and good hygiene practices (GHP)

Pickles shall be manufactured according to requirements set out in the mandatory standard 656:2002 (General Principles of Food Hygiene) and its related mandatory guideline, as well as the decision of the Minister of Industry 1/1 dated on 5/1/2015 (General requirements in food processing establishments).

Personnel

- **Disease control**

Any person who has an illness, open lesions (including boils, sores, or infected wounds), or any other abnormal source of microbial contamination must not work in any operation (in a food processing center), which could result in the food, food-contact surface, or food packaging materials becoming contaminated.

- **Cleanliness**

The following applies to people who work in direct contact with food preparation, food ingredients, or surfaces of equipment or utensils that will contact food. They must wear clean outer garments, maintain a high degree of personal cleanliness, and conform to hygienic practices while on duty. They must wash their hands thoroughly and they must also sanitize their hands before starting specific tasks, after each absence from the workstation, and at

any other time when the hands have become soiled or contaminated. They must also remove all unsecured jewelry that cannot be properly sanitized from their hands, especially individuals who are actually handling food. It is necessary to wear effective hair restraints, such as hairnets, caps, headbands, or beard covers. Operators must not store clothing or other personal belongings in food processing areas. Also, eating food, drinking beverage, or using tobacco (in any form) must not be allowed in the food processing areas. All necessary steps have to be taken by supervisors to prevent operators from contaminating foods with microorganisms or foreign substances such as perspiration, hair, cosmetics, tobacco, chemicals, and medicants.

- **Education and training**

Persons who are monitoring the sanitation programs must have the education and/or experience to demonstrate that they are qualified. Food handlers and supervisors should receive training that will make them aware of the danger of poor personal hygiene and unsanitary work habits.

- **Supervision**

It is crucial to have a supervisor who must be responsible for the compliance of all personnel with all the requirements of these GMP's.

Plants and grounds

The surfaces around a food processing center, which are under the control of this center, must be free from conditions such as: improperly stored equipment; litter, waste, or refuse; uncut weeds or grass close to buildings; excessively dusty roads, yards, or parking lots; inadequately drained areas; potential foot-borne filth or breeding places for insects or microorganisms; or inadequately operated systems for waste treatment and disposal.

Plant construction and design shall: provide enough space for sanitary arrangement of equipment and storage of materials; floors, walls, and ceilings must be kept clean and in good repair, and must be constructed in a way that facilitates cleaning activities; separate by partition, location, time and other means, any operations that may cause cross-contamination of food products with undesirable microorganisms, chemicals, filth or other extraneous material; provide effective screening or other protection to keep out birds, animals, and vermin such as insects and rodents; provide adequate ventilation to prevent contamination of foods with odors, noxious fumes, or vapors (including steam); light bulbs, skylights, or any other glass must be of the safety type or protected so that glass contamination cannot occur in case of breakage.

Sanitary operations and Hygiene

This section elaborates on the general definitions and recommendations that any food processing plant or industry should adopt. The norms and regulations required by the Lebanese government can be found at LIBNOR under the following code: NL 656:2002/General principles for food hygiene.

Manufacturing hygiene aims to prevent product contamination that may occur through the introduction of unwanted materials, substances, or microorganisms into a manufactured good or process. Good hygiene practices reduce the likelihood of the introduction, spread, and multiplication of potential pathogens and other spoilage organisms in the manufacturing environment. This ensures the protection of the industrial workers as well as the consumers, which use the manufactured products.

Hygiene in manufacturing is vital, since a contaminated production batch has the potential to affect the health of many people, or to result in spoilage and waste. Obviously, different industry sectors also have different hygiene requirements depending on the nature of the products being manufactured.

General maintenance

The plant and all fixtures must be kept in good condition and should be maintained in a sanitary state. Cleaning operations must be conducted in a manner that will minimize the possibility of contaminating foods, equipments, or surfaces in contact with the food products.

Pest control

- Animals and/or birds are not allowed anywhere in the plant
- Effective programs should be applied to prevent contamination by animals, birds, and pests (such as rodents and insects)
- Insecticides and rodenticides may be used as long as they are used properly (according to label instructions)
- Pesticides must not contaminate food or packaging materials with illegal residues

Sanitation of equipment and utensils

- Utensils and equipment surfaces that are in contact with food must be cleaned as often as necessary to prevent food contamination

- Equipment surfaces that are not in contact with food should be cleaned as frequently as necessary to minimize accumulation of dust, dirt, food particles, etc.
- Single-service articles such as disposable utensils, paper cups, paper towels, among others, should be stored in appropriate containers, handled, dispensed, used, and disposed of in a manner that prevents contamination of food or equipment
- All utensils and equipment surfaces that contact food must be cleaned and sanitized before use and following any interruption during which they may have become contaminated, in order to eliminate the possibility of introducing undesirable microorganisms into food
- When utensils or equipment are used in a continuous production operation, they must be cleaned and sanitized on a predetermined schedule
- Any facility, procedure, machine, or device may be used for cleaning and sanitizing, as long as it has proved to be effective and will lead to the intended result

Storage and handling of clean portable equipment and utensils

When portable equipment or utensils, which have surfaces that will come into contact with foods, are cleaned and sanitized, they should be stored in a manner that will protect these surfaces from splash, dust, and other contamination.

Sanitary facilities and controls

Water supply

Water that comes into contact with food or processing equipment must be safe and of adequate sanitary quality.

Sewage disposal

Sewage must flow into an adequate sewage system or disposed of through other adequate means.

Plumbing

Plumbing must be of adequate size and design to:

- a. Supply enough water to areas in the plant where it is needed.
- b. Properly convey sewage or disposable liquid waste from the plant.
- c. Avoid the creation of a source of contamination or unsanitary condition.
- d. Provide adequate floor drainage where hosing-type cleaning is done or where operations discharge water or liquid waste onto the floor.
- e. Ensure that there is no back-flow from the cross-connection between the piping systems that discharge waste water or sewage and those that carry water for food or the food manufacturing process.

Toilet facilities

- a. Toilets and hand-washing facilities must be provided inside the fruit and vegetable processing centers.
- b. Toilets must be kept sanitary and in good repair.
- c. Toilet rooms must not open directly into areas where food is exposed unless steps have been taken to prevent airborne contamination (example: double doors, positive airflow, etc.).
- d. Signs must be posted that direct employees to wash their hands with soap or detergent after using the toilet.

Hand-washing facilities

- a. Adequate and convenient hand-washing and, if necessary, hand-sanitizing facilities must be provided anywhere in the plant.
- b. These hand-washing facilities must provide:
 1. Running water
 2. Effective hand-cleaning and hand-sanitizing preparations
 3. Clean towel service or suitable drying devices
 4. Easily cleanable waste receptacle

Equipment and utensils

- a. Equipment and utensils must be designed and constructed so that they are adequately cleanable and will not adulterate food with lubricants, fuel, metal fragments, contaminated water, and other unwanted substances.
- b. Equipment should be installed in a way that allows the cleaning of the surrounding area as well as the equipment.
- c. Food contact surfaces shall be made of nontoxic materials and must be corrosion-resistant.
- d. Seams on food-contact surfaces shall be smoothly bonded or maintained in order to minimize the accumulation of food particles, dirt, and organic matter.
- e. Equipment in processing areas, which does not come into contact with food, should be constructed in a way that allows the cleaning of such piece of equipment.
- f. Holding, conveying, and manufacturing systems, including gravimetric, pneumatic, closed and automated systems, must be maintained in a sanitary condition.
- g. Each freezer and cold storage compartment should have an indicating thermometer, temperature measuring, or recording device, and should have an automatic control for regulating temperature or an automatic alarm system to indicate a significant temperature change.
- h. Instruments and controls used for measuring, regulating, or recording temperatures, pH, acidity, and water activity should be accurate and maintained.

Processes and controls

Raw materials and ingredients

- a. Must be inspected and sorted to ensure that they are clean, wholesome, and fit for processing into human food.
- b. Must be stored under conditions that will protect against contamination and minimize deterioration.
- c. Must be washed or cleaned to remove soil and other contamination:
 - Water used for washing, rinsing, or conveying food products must be of sanitary quality.
 - Water must not be reused for washing, rinsing, or conveying if it can result in the contamination of the food products.
 - Containers and carriers (such as trucks or railcars) should be inspected to ensure that their condition is safe and not contaminated by previous raw materials and ingredients.
- d. Raw materials should not contain levels of microorganisms that may produce food poisoning or other diseases. In case there is any level of such microorganisms, the raw materials should be pasteurized or otherwise treated during manufacturing operations so that the product will not be adulterated.
- e. Materials susceptible to contamination with natural toxins (e.g. aflatoxin) must comply with national and international official levels before they are incorporated into the produced food.
- f. Materials susceptible to contamination with pests, undesirable microorganisms, or extraneous material, have to comply with national and international regulations, guidelines, and defect action levels.
- g. Materials should be stored in containers and under conditions which protect against contamination.
- h. Frozen materials must be kept frozen. If thawing is required prior to use, it shall be done in a manner that prevents contamination.

Manufacturing operations

- a. Food processing equipment must be kept in a sanitary condition through frequent cleaning and, when necessary, sanitizing. If necessary, such equipment must be taken apart for thorough cleaning.
- b. It is necessary to process, pack, and store food under conditions that will minimize the potential for undesirable microbiological growth, toxin formation, deterioration or contamination. To accomplish it, this may require careful monitoring of factors such as time, temperature, humidity, pressure, flow rate, among other indicators. The object is to assure that mechanical breakdowns, time delays, temperature fluctuations, or other factors do not allow the foods to decompose or become contaminated.
- c. Food should be held under conditions that prevent the growth of undesirable microorganisms.

- d. Measures such as sterilizing, irradiating, and pasteurizing, have to be performed adequately to destroy or prevent the growth of undesirable microorganisms.
- e. Work-in-process must be protected against contamination.
- f. Equipment, containers, and utensils should be constructed, handled, and maintained to protect against contamination.
- g. Food or materials that are adulterated must be disposed of in a manner that prevents other food products from being contaminated.
- h. Mechanical manufacturing steps (such as washing and peeling) should be performed to protect against contamination by providing adequate protection from contaminants that may drip, drain, or be drawn into the food. This can be done by adequately cleaning and sanitizing all food-contact surfaces and by using time and temperature controls at and between each manufacturing step.
- i. Heat-blanching should be done by heating the food to the required temperature and time, and then either rapidly cooling the food or passing it to the next manufacturing step without delay.
- j. Filling, assembling, packaging, and other operations should be performed in a way that protects the food against contamination. This is ensured by following the adequate cleaning and sanitizing procedures for all of the food-contact surfaces and food containers.
- k. Areas and equipment that are used to process human food should not be used to process non-human food-grade animal feed or inedible products unless there is no possibility of contaminating the human food.
- l. A coding system should be utilized, in case of need, to allow positive lot identification and segregate lots of food that may be contaminated.

Labelling

Customers and consumers expect the labelling on food to be a true description of what they are buying.

Misleading or fraudulent labelling is an unfair trade practice that cannot be tolerated. Most countries now have labelling laws stipulating how foods are to be labelled and what information must be included on the labels. Most, if not all of those laws have a common requirement that the label should bear:

- Name and address of the manufacturer, packer, distributor or consigner
 - Statement of identity and a true, non-misleading description of the product (i.e. the name of the product must include the indication of the packing medium and the presentation style)
- Declaration of net and drained weight in international units
- List of ingredients (in descending order of volume or weight)
- List of food additives and related warnings and precautions
- Storage instructions

- Batch number (or otherwise production date)
 - Country of origin
 - Production date and expiry date
 - Nutritional qualities or values of the food

Consignments of exported food to foreign markets are often denied entry because the labelling does not comply with the mandatory requirements of the importing country.

This sometimes results in consignments being rejected, but more often in them being withheld from entry until the labelling is corrected or a new labelling is used. In either case, trade is interrupted, which could raise costs and make sales unprofitable. It is essential therefore, that exporters be familiar with the food labelling requirements of importing countries.

The specific labelling requirements for the Lebanese markets are set in the mandatory standard issued by LIBNOR NL 206:2017 and its amendments (General Standard for the Labelling of Prepackaged Foods).

INNOVATION IN THE PICKLE SECTOR

Innovation is the creation, development, and implementation of a new product, process, or service with the aim of improving efficiency, effectiveness, or competitive advantage.

Innovation increases the flexibility to react to changes and discover new opportunities. It can also help foster competitive advantage as it allows producers to build better products and services for their customers.

In the world of pickling, innovation can play a major role in attracting new customers and gaining big profits, since it has a very wide range and could be done easily. These innovations focus mainly on:

- Use of new combination of flavorings
- Use of new type of pickling liquor
- Use of mixes of fruits and vegetables

Below are two successful recipes of pickle innovations called sweet pickling, which can pave the way for a variety of combinations and products:

Recipe 1: Sweet Mixed Vegetables¹¹

Ingredients:

- Assorted Vegetables
- 2.5 cups of white vinegar
- 2 cups of sugar
- 0.5 of an onion (well chopped)
- 2 tablespoons of salt
- 1 tablespoon of mustard seed
- 1 teaspoon ground turmeric



Method

- Prepare the vegetables you will use:
 - Cucumber: Do not remove the skin. Slice the cucumbers into round cylinders, about 1cm thick or less.
 - Capsicum: Remove the seeds and membrane. Char the skin of the capsicum under a griller until it blisters and goes black. Place the hot capsicum into a plastic bag to sweat, which facilitates the removal of the skin.
 - Carrots: Peel and julienne the carrots.
 - Broccoli and cauliflower: Cut the broccoli and cauliflower into small florets.

¹¹https://www.annettemcfarlane.com/_Veg_Pickled.htm

- Sterilize the glass jars and lids in boiling water. Pack the vegetables tightly into the jar (individually or mixed). Then set vegetable-filled jars aside.
- Place all other ingredients into a saucepan. Bring to the boil to dissolve the salt and sugar. Then simmer for about 5 minutes.
- Pour the hot vinegar mix into the vegetable-filled jars. Fill to the top and seal. The hot vinegar cooks the vegetables but they will remain crisp. If you prefer them soft, you can lightly steam carrots, cauliflowers, and broccoli before placing them into jars.
- Once cool, place the jars in the refrigerator. Shake gently each day for the first three days of storage to redistribute the spices. Vegetables can be eaten after three days, or could be stored for three months or more with proper refrigeration.

Recipe 2: Gingery Sweet pickles¹² (to mention the source of these recipes)

Ingredients:

- 0.2 Kg 5- to 7-cm pickling cucumbers
- 1 teaspoon pickling salt
- 0.5 cup peeled, thin-sliced fresh ginger
- 2 small dried chili peppers
- 1.5 cups rice vinegar
- 1.5 cups water
- 1.5 cups sugar
- 2 cups diagonal carrot slices (1.2 cm thick)
- 1 large bell pepper, cut into 2.5 cm squares
- 0.34 kg of onions (1 large or 2 medium), cut into 2.5 cm chunks



Method:

- Gently wash the cucumbers and cut them into 1-inch lengths, discarding a thin slice from each end. Toss the cucumbers with 1/2 teaspoon salt in a bowl. Let the cucumbers stand for one to two hours.
- In a large nonreactive saucepan, bring to a boil the ginger, chili peppers, vinegar, water, sugar, and remaining 1/2 teaspoon salt, stirring to dissolve the sugar and salt. Remove the pot from the heat and add the carrots. Let the mixture cool.
- Drain and rinse the cucumbers, and then drain them again. Add the cucumbers, pepper, and onions to the saucepan. Mix well, and then transfer the vegetables and liquid to a 2 liters jar. Cover the jar with a nonreactive cap and refrigerate it.
- The pickles will be ready to eat after about three days. They can be stored for at least two months if refrigerated properly.

¹²<https://www.epicurious.com/recipes/food/views/gingery-sweet-pickled-vegetables-102096>

CONCLUSION

As local production tends to cover most of local demand and given the substantial trade surplus in pickles, the industry presents large opportunities for producers, with low risk of losing market share to foreign companies on the short term. In fact, locally produced pickles have almost been able to replace imported pickles, while more than 60% of pickles are exported abroad.

This phenomenon shows the availability of vegetables needed to produce the majority of locally demanded types of pickles.

In addition, the existing know-how in the production of such products as well as the tradition of pickling have both made pickles part of the Lebanese “Mounneh”, which is why it is highly demanded by the Lebanese diaspora worldwide.

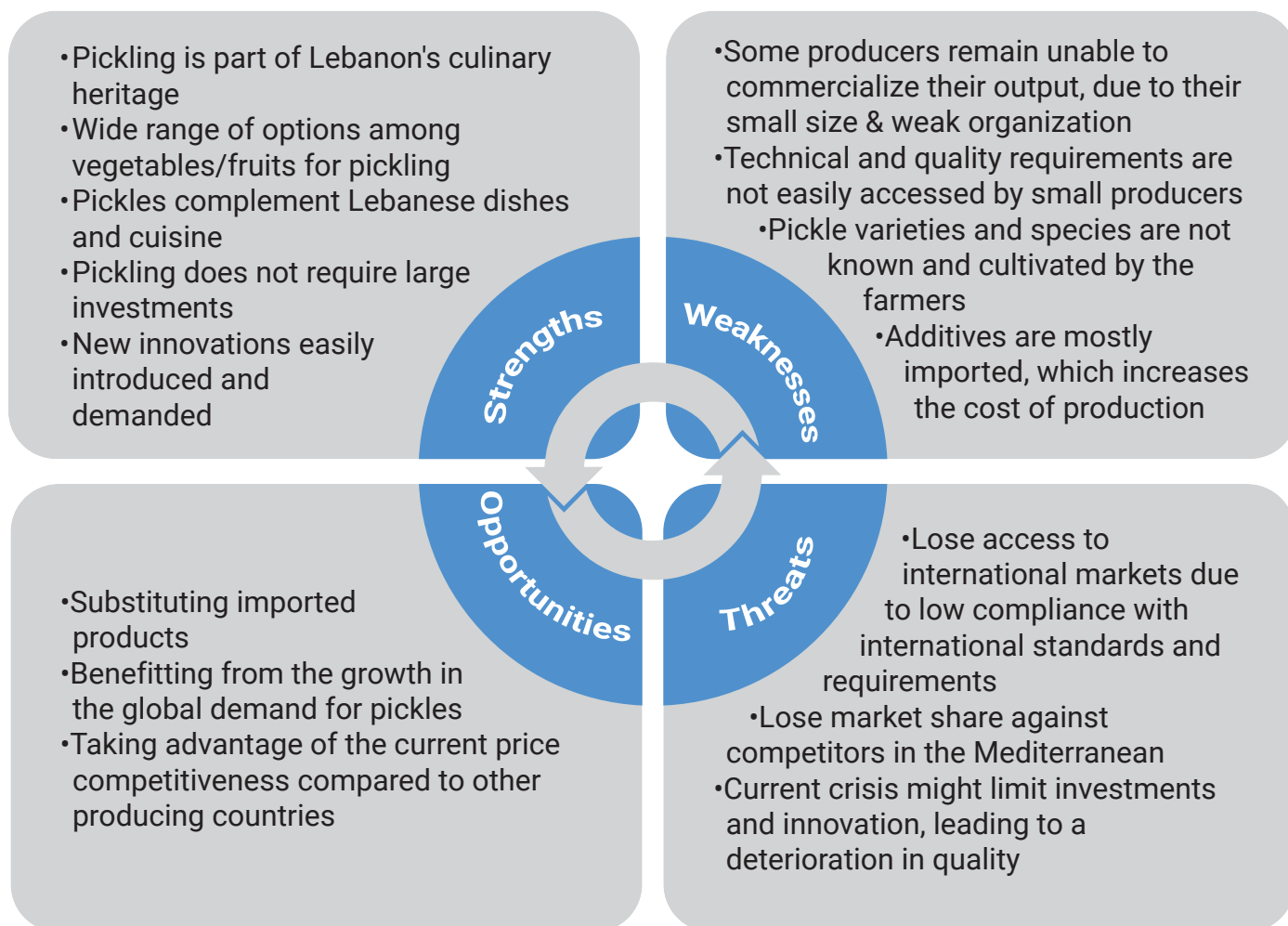
Also, the depreciation of the Lebanese pound in the parallel market has made imported pickles less competitive, which makes it easier to substitute these products with locally-produced pickles, and helps the latter become more competitive abroad. As such, this industry remains a key segment of Lebanon’s agri-food products and has an increasing potential, as global food trends continue to converge towards healthy food.

Consequently, it is necessary to abide by the aforementioned technical and quality requirements in order to access the Lebanese market as well as to benefit from the growing markets for pickles globally.

Also, the industry has room for innovation on several fronts, including the means of production in order to make the process more efficient and less costly, as well as the recipes in order to have a wider range of pickled products and to introduce new tastes to the culinary experience in Lebanon and abroad.

Increased efforts to abide by international standards, to innovate, and to improve customer perception of the pickle industry, regionally and globally, are currently crucial to maintain and raise the producers’ export potential, as the current economic and financial crises in Lebanon weigh on the capacity of the local market to absorb these products. As such, the willingness, the capacity, and the possibility to find a potential buyer to export has become a major lifeline for businesses in Lebanon.

SWOT ANALYSIS



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