REPUBLIC OF LEBANON
MINISTRY OF INDUSTRY

PSDP
Productive Sectors Development Programme
A programme by UN Lebanon

Pre-Feasibility Study
Dried Fruits & Vegetables Industry

March 2022

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, that 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 chocolate industry within the Lebanese market, while focusing on its potential to become more competitive and prominent. 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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ACKNOWLEDGMENTS

The development of the pre-feasibility study report is a joint work between the United Nations Industrial Development Organization (UNIDO) and the Ministry of Industry (MoI), as part of its Productive Sectors Development Programme (PSDP). The PSDP is a UN joint programme, funded by Canada and implemented by six UN agencies (UNIDO, UNDP, ILO, UNICEF, FAO & UN Women) and coordinated by the Resident Coordinator's Office (RCO). This report was drafted by Ms. Lina Assi (Agri-Food Engineer, Head of Standards and Quality Inspection Department, MoI), Ms. Christel Hanna (Economist, MoI), Ms. Manal Yassine (Economist, MoI), Ms. Mariam Khamis (Economist, MoI), Ms. Marilyse Chehab (Economist, MoI), Ms. Sirana Fakhri (Economist, MoI) and Mr. Bassam Jouny (Economist, MoI), Ms. Nour Mrad (Project Assistant, UNIDO), Mr. Elie El Khoury (Economist, UNIDO) and Mr. Julian Barhoun (Senior Project Assistant, UNIDO). Oversight and coordination were done by Mr. Kjell Sundin (UNIDO Project Manager) and Ms. Nivine Chahni (Project Coordinator).

DEFINITION

Drying is the oldest method of preserving food. Throughout history, the sun, the wind and smoky fire were used to remove water from fruits, meats, grains and herbs. By definition, food dehydration is the process of removing water from food by circulating hot air through it, which prohibits the growth of enzymes and bacteria.
Dried foods are tasty, nutritious, lightweight, easy to prepare and easy to store and use. The energy input is less than what is needed to freeze or can, and the storage space is minimal compared with that needed for canning jars and freezer containers.

In Lebanon the market for dried fruits and vegetables is beginning to take shape with new varieties being available on the shelves of the supermarkets and at home. Preferred mainly for their health benefits, dried tomatoes and dried apples or apple chips are becoming the new favorite snacks for many, moreover powdered veggies are being used more and more in the kitchen as flavorings and fresh vegetables subsidies.
The nutritional value of food is only minimally affected by drying:

- Vitamin A is retained during drying; however, because vitamin A is light sensitive, food containing it should be stored in dark places. Yellow and dark green vegetables such as peppers, carrots, winter squash and sweet potatoes have high vitamin A content.
- Vitamin C is destroyed by exposure to heat, although pretreating foods with lemon, orange or pineapple juice increases vitamin C content.

Dried fruits and vegetables are high in fiber and carbohydrates and low in fat, making them healthy food choices. Dried fruit has a higher concentration of carbohydrate than fresh fruit; therefore, serving sizes tend to be smaller. According to the USDA's Dietary Guidelines for Americans, ½ cup of dried fruit is equivalent to 1 cup of fresh fruit.

Dried fruit is highly nutritious. One piece of dried fruit contains about the same amount of nutrients as the fresh fruit, but condensed in a much smaller package. By weight, dried fruit contains up to 3.5 times the fiber, vitamins and minerals of fresh fruit.

Dried fruit are fruits from which water is removed to prevent microbial growth. This method includes dried fruit leathers (fruit rolls) prepared by drying fruit purees.

Most common dried fruits include dried apple slices, dried orange slices, raisins, dried shredded or flaked coconut, and prunes.

Dried vegetables are products in which the natural water content has been reduced below that critical for growth for microorganisms without affecting the important nutrients. This technique includes vegetable powders that are obtained from drying the juice, such as tomato powder and beet powder.
Most common dried vegetables include tomatoes, mushrooms and fungi, roots and tubers, pulses and legumes, aloe Vera, seaweeds, dried potato flakes, lentils, nuts, and seeds.

MACRO TRENDS

I- Market Size – Global, Regional and Local

- Internationally the market for dried fruits and vegetables is growing due to the change in people's behavior in preparing and consuming food. Dried fruits are heavily consumed as a healthy snack alternatively to fatty snacks. While the dried vegetables offer the availability of seasonal vegetables all year round.

- The demand for powdered fruits, nutraceutical products and superfruit powders are partial drivers behind the growth of dried fruits and vegetables market.[1]

- The busy lifestyle is driving the consumption of convenience foods, which in turn is fueling the demand of dried fruits and vegetables.

- Dehydrated vegetables are highly demanded as they are nutritious and healthy, easy to store, fit well with plant-based diet, also they reduce waste and do not include preservative or chemical products.[2]

- The market for global freeze-dried fruits and vegetables is expected to increase by a compounded annual growth rate of 6.6% in the 2021-26 period.[3]

- According to INC international Nut&DriedFruit, tree nut and dried fruit supply is estimated at about $46.7bn in 2021, with tree nuts representing a share of 83% of the total, while fruits accounted for the remaining 17%. The supply grew by a CAGR of 5.6%, with most of the growth stemming from the increase in the production of tree nuts, while the supply of dried fruits was relatively stable over the same period with a CAGR of 4.5%.

- The global dried vegetables market size is estimated at $12.8bn in 2020.[4]

- Dried grapes represented a share of 36.7% of the total global supply of fruits, followed by table dates (36.6%), SD cranberries (9.6%), dried figs (7.4%), dried apricots (5.2%) and prunes (4.4%).

- The consumption of dried fruits was estimated at 2.9 million metric tons in 2019, with dried grapes accounting for 44% of the total, followed by table dates (30%), prunes (8%), SD cranberries (7%), dried apricots (6%), and dried figs (5%). The Middle East was the top

[1]Global dehydrated fruits & vegetables market, Market Research Future
[2]Why dehydrated vegetables are in huge demand in international market, Organic Products India
[3]FREEZE DRIED FRUITS AND VEGETABLES MARKET - GROWTH, TRENDS, COVID-19 IMPACT, AND FORECASTS (2021 - 2026), Mordor Intelligence
[4]Global Dried Vegetables Market 2021 by Manufacturers, Regions, Type and Application, Forecast to 2026, Market.biz

consuming region with a share of 29% of the total, followed by Europe (24%), Asia (20%), North America (15%), Africa (6%), Latin America (4%) and Oceania (2%).[5]

- As for Tree nuts, the global consumption was estimated at about 4.5 million metric tons in 2019, with almonds and walnuts accounting for 30% and 20%, respectively. Europe was the main market with a share of 30% of the total, followed by Asia (25%), North America (24%), the Middle East (13%), Africa and Latin America (3% each) and Oceania (2%).

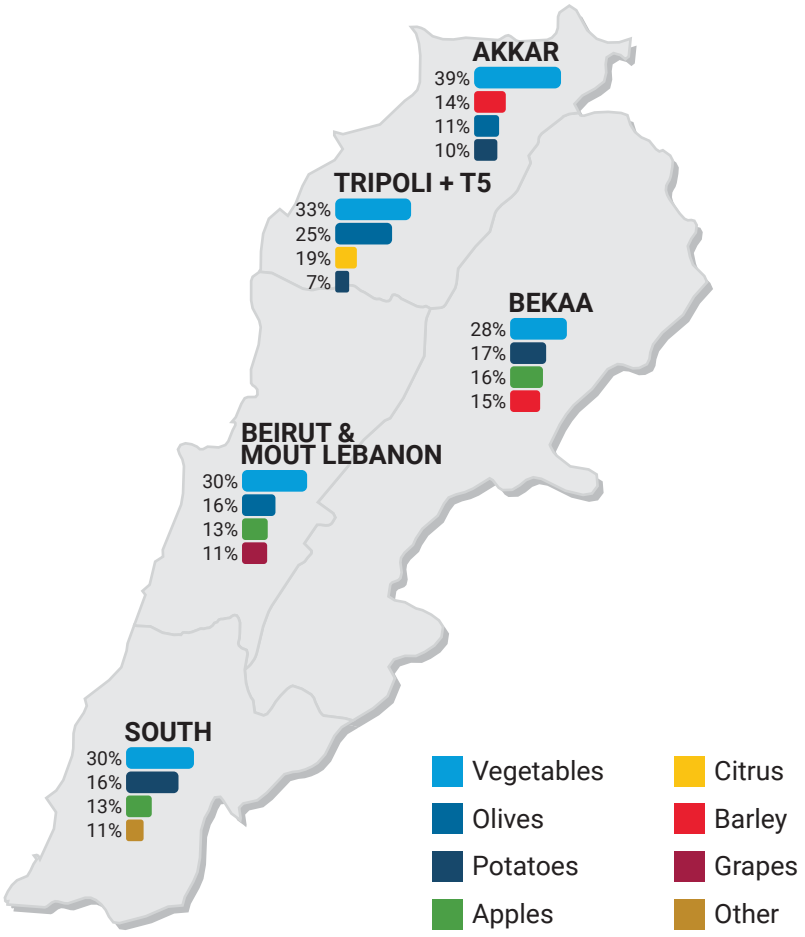
- Peanuts consumption was estimated at about 42 million metric tons in 2019.

- Dried fruits and tree nuts were mainly demanded by high and middle-income economies, while peanuts were mainly consumed in middle-income countries.

According to the Food and Agriculture Organization of the United Nations, Lebanon produced about 2.7 million tons of crops in 2020. The crops are mainly constituted of potatoes, tomatoes, apples, oranges, wheat, olives, cucumbers and gherkins, lemons and limes, bananas, onions, grapes, watermelons, cabbages and other brassicas, peaches and nectarines, fruits not elsewhere specified, plums and sloe, apricots, cherries, pears, barley and almonds.
Lebanon exported about 257,624 tons of edible fruits and nuts (HS 08) and about 101,187 tons of edible vegetables and certain roots and tubers (fresh or dried) (HS 07) in 2020.[6] In parallel, the country imported 40,185 tons of edible fruits and nuts and 183,907 tons of edible vegetables in 2020. The difference between the produced crops and the exported volume, as well as the imported volume of edible fruits, nuts and vegetables reflect the large size of the locally consumed crops in Lebanon in the form of fresh products or processed, including dried fruits and vegetables. The processing and preserving of fruits and vegetables was estimated at $250.4m in 2011.[7]

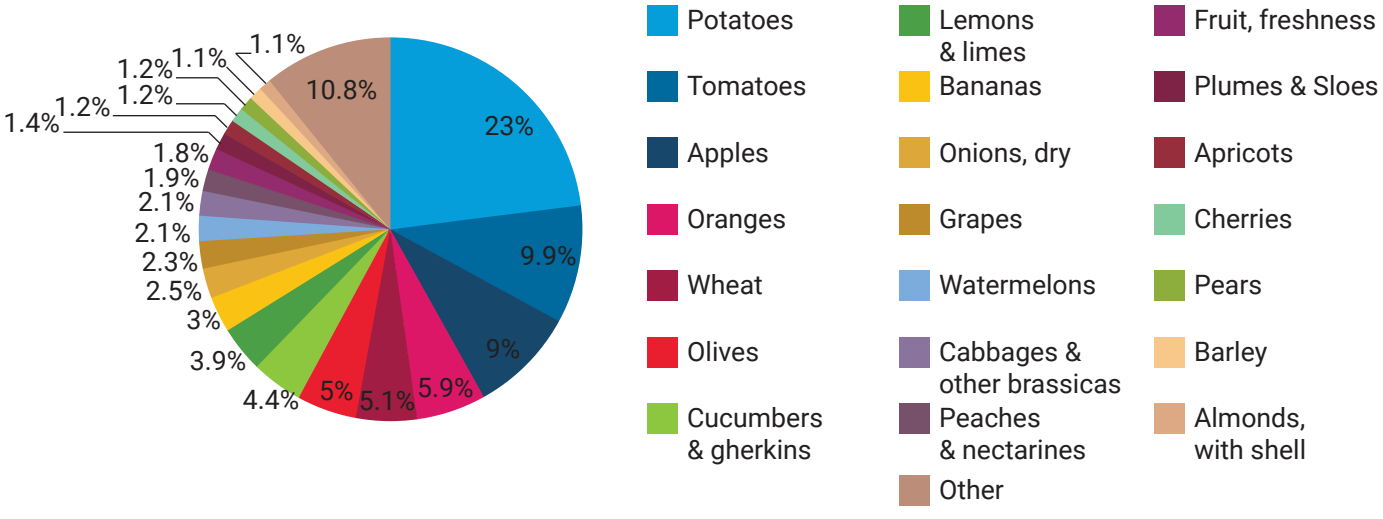
The Ministry of Agriculture provides the main location, altitude and season of the production of certain crops. This can help industrials or potential investors to choose carefully their operating sites in order to cut transportation costs, time and risks.
Also, the FAO provided a map on the top crops cultivated according to different regions in Lebanon.

[5]Nut & Dried Fruits Statistical Yearbook 2020/2021, INC International Nut&DriedFruit
[6]ITC Trade Map
[7]Road Map for the Agro-food Sector in Lebanon – UNIDO, Consultation % Research Institute



Crops in Lebanon by Operational Area, Source Food Security and Livelihoods Assessment of Lebanese Hosting Communities (June 2015)

Figure 1: Main Crops Produced in Lebanon % (2020)



Source: FAOSTAT

Exported quantity of edible fruits and nuts (2020)

Code	Product label	Exported quantity, Tons
'0808	Apples, pears and quinces, fresh	58920
'0805	Citrus fruit, fresh or dried	56194
'0806	Grapes, fresh or dried	45915
'0803	Bananas, incl. plantains, fresh or dried	44112
'0809	Apricots, cherries, peaches incl. nectarines, plums & sloes, fresh	34028
'0810	"Fresh strawberries, raspberries, blackberries, back, white or red currants, gooseberries and ...	8487
'0804	Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, fresh or dried	5808
'0807	Melons, incl. watermelons, and papaws (papayas), fresh	2000
'0802	Other nuts, fresh or dried, whether or not shelled or peeled (excluding coconuts, Brazil nuts...	1577
'0811	Fruit and nuts, uncooked or cooked by steaming or boiling in water, frozen, whether or not...	344
'0801	Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled	94
'0813	"Dried apricots, prunes, apples, peaches, pears, papaws ""papayas"", tamarinds and other edible...	93
'0812	Fruit and nuts, provisionally preserved, e.g. by sulphur dioxide gas, in brine, in sulphur...	52
	Total	**257624**

Source: ITC Trade Map

Exported quantity of vegetables (2020)

Code	Product label	Exported quantity, Tons
'0701	Potatoes, fresh or chilled	67466
'0705	"Lettuce ""Lactuca sativa"" and chicory ""Cichorium spp."", fresh or chilled"	7670
'0710	Vegetables, uncooked or cooked by steaming or boiling in water, frozen	7132
'0703	Onions, shallots, garlic, leeks and other alliaceous vegetables, fresh or chilled	7119
'0713	Dried leguminous vegetables, shelled, whether or not skinned or split	6251
'0709	"Other vegetables, fresh or chilled (excluding potatoes, tomatoes, alliaceous vegetables, edible...	2392
'0702	Tomatoes, fresh or chilled	870
'0708	Leguminous vegetables, shelled or unshelled, fresh or chilled	712
'0706	Carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, fresh...	476
'0711	Vegetables provisionally preserved, e.g. by sulphur dioxide gas, in brine, in sulphur water...	294
'0712	Dried vegetables, whole, cut, sliced, broken or in powder, but not further prepared	278
'0704	Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas, fresh or chilled	262
'0707	Cucumbers and gherkins, fresh or chilled	244
'0714	Roots and tubers of manioc, arrowroot, salep, Jerusalem artichokes, sweet potatoes and similar...	21
	Total	**101187**

Source: ITC Trade Map

II. Trade Performance

Lebanon is a net exporter of fresh fruits and vegetables, with yearly imports of about €185 million and exports worth of about €225 million.[8] This shows a significant potential for fruits and vegetables processing to satisfy the local market, which still imports a large amount of dried fruits and vegetables, but also for the export market, following the steps of fresh products destined mainly to the Middle East given the proximity. However, given the longer life shelf of dried fruits and vegetables there are alternative opportunities in other regions that are already a destination for some Lebanese producers. These destinations are highlighted in Figure 2.

As per the calculations of the Investment Development Authority of Lebanon, the exports of dried fruits and nuts reached $45m in 2019. This segment accounted for 10% of exported agri-food products in 2019. Also, there are large opportunities for these exports to expand in Saudi Arabia, Egypt and Spain, with untapped potentials of $7.7m, $t2.25m and $1.69m, respectively.[9]
Exports of dried vegetables and leguminous vegetables have been growing significantly since 2001, by CAGRs of 14% and 9% to $533,000 and $5.6m in 2020, respectively. However, dried vegetables peaked in 2015 at $647,000, while dried leguminous vegetables reached $10.7m in 2016.

Lebanon imports of dried vegetables and leguminous vegetables remain large at $2.3 million and $44 million, respectively, in 2020, reflecting a compounded annual growth rate of 0.4% and 4.2%, respectively since 2001. The dried leguminous vegetables mainly included dried shelled lentils ($14.3m), dried shelled chickpeas ($13.6m), dried shelled kidney beans ($8.1m), dried shelled broad beans ($5m) and dried shelled beans ($2m). However, they peaked in 2017, but since then, they have been on a declining trend. The size of imports reflects the large market for dried vegetables in Lebanon. Imports of dried leguminous vegetables represent the largest imported product under the category of edible vegetables and certain roots and tubers (HS 07).

In terms of edible fruits and nuts (HS Code 08), Lebanon exported about $121.4m in 2020, reaching the highest level of such exports so far, and constituting a growth of 69% year-on-year. This segment includes both fresh and dried products. In comparison, the imports of edible fruits and nuts peaked in 2017 at $191.2m and declined significantly to $73.5m in 2020, reflecting the increase in competitiveness of locally produced foods. The largest imported component under edible fruits and nuts was the category of other nuts, fresh or dried, whether or not shelled or peeled (excluding coconuts, Brazilian nuts and cashew nuts) (HS 0802). This category consists mainly of fresh or dried almonds shelled, fresh or dried pistachios, in shell, fresh or dried pistachios, shelled, fresh or dried chestnuts in shell, fresh or dried hazelnuts or filberts in shell, and fresh or dried walnuts, shelled and in shell.

[8]Value Chain Analysis Lebanon Fresh Fruit and Vegetables, CBI (December 2018)
[9]Agri-Food Sector in Lebanon 2020 Factbook, IDAL

You can find some of the dried fruits, vegetables and nuts under the below HS codes on the Customs Administration website in order to monitor the volumes and values of exported or imported products, as well as for recent data:

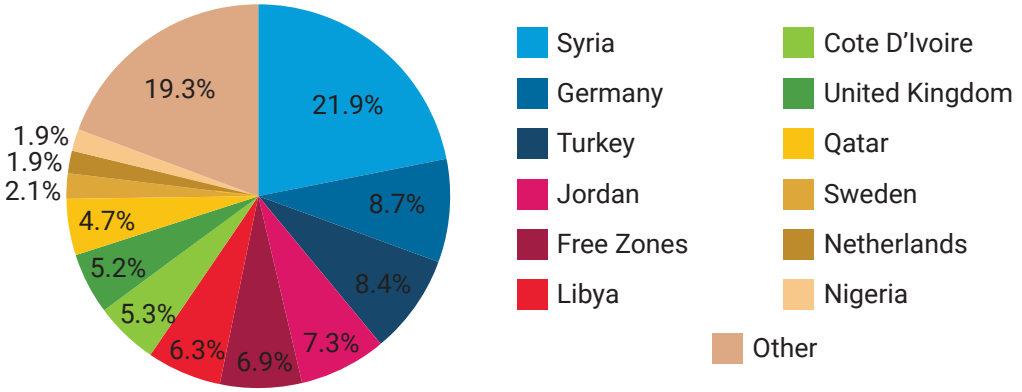
- 07.12 Dried Vegetables
- 07.13 Dried Leguminous Vegetables
- 08.01 Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled*
- 08.02 Other nuts, fresh or dried, whether or not shelled or peeled*
- 08.03 Bananas, including plantains, fresh or dried*
- 08.04 Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, fresh or dried*
- 08.05 Citrus fruit, fresh or dried*
- 08.06 Grapes, fresh or dried*
- 08.13 Fruit, dried, other than that of headings Nos. 08.01 to 08.06; mixtures of nuts or dried fruits of this Chapter
- 08.14 Peel of citrus fruit or melons (including watermelons), fresh, frozen, dried or provisionally preserved in brine, in sulphur water or in other preservative solutions*

*Headings include fresh and dried products

Table 2: Exports of edible fruits and nuts (HS Code 08) in thousand US dollars

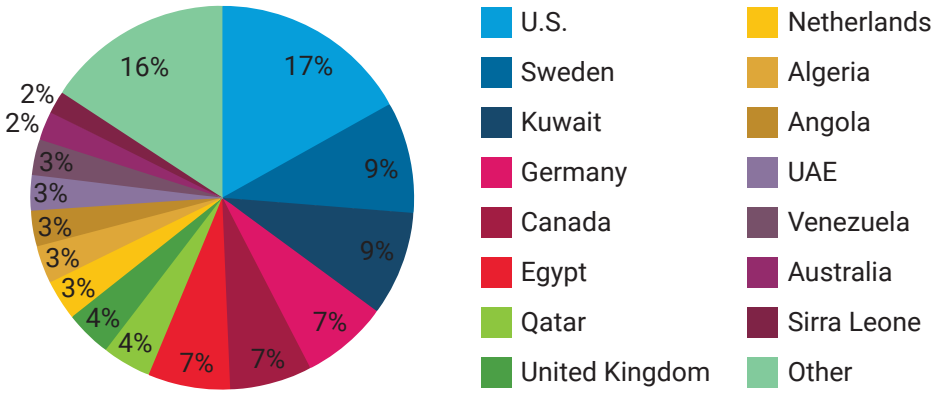
HS	Description	2012	2013	2014	2015	2016	2017	2018	2019	2020
8.01	Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled	322	180	672	507	127	156	100	556	341
8.02	Other nuts, fresh or dried, whether or not shelled or peeled	2,700	13,977	2,611	1,803	2,022	1,481	1,578	4,110	19,041
8.03	Bananas, including plantains, fresh or dried	17,060	17,160	12,435	13,132	21,243	12,612	22,043	12,785	22,020
8.04	Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, fresh or dried	1,490	1,615	1,677	1,940	2,109	2,440	3,714	3,185	5,903
8.05	Citrus fruit, fresh or dried	18,749	15,264	15,363	11,782	11,667	11,450	11,186	10,755	17,491
8.06	Grapes, fresh or dried	6,742	7,184	7,359	5,633	6,865	9,438	11,757	14,653	21,118
8.07	Melons (including watermelons) and papaws (papayas), fresh	553	884	639	325	329	238	307	509	704
8.08	Apples, pears and quinces, fresh	21,496	16,707	13,399	13,810	16,120	16,521	14,813	10,869	13,505
8.09	Apricots, cherries, peaches (including nectarines), plums and sloes, fresh	8,605	8,232	6,037	7,360	8,543	7,744	7,774	9,606	13,409
8.10	Other fruit, fresh	3,278	2,624	2,604	2,887	3,698	3,228	3,764	3,921	6,102
8.11	Fruit and nuts, uncooked or cooked by steaming or boiling in water, frozen, whether or not containing added sugar or other sweetening matter	10	39	51	8	21	76	275	346	354
8.12	Fruit and nuts, provisionally preserved (for example, by sulphur dioxide gas, in brine, in sulphur water or in other preservative solutions), but unsuitable in that state for immediate consumption	226	154	2	0	0	1	27	37	31
8.13	Fruit, dried, other than that of headings Nos. 08.01 to 08.06; mixtures of nuts or dried fruits of this Chapter	363	477	794	905	715	646	584	483	273
8.14	Peel of citrus fruit or melons (including watermelons), fresh, frozen, dried or provisionally preserved in brine, in sulphur water or in other preservative solutions.	0	0	0	5	8	0	0	8	1
	TOTAL	81,595	84,496	63,645	60,098	73,467	66,033	77,922	71,821	120,293

Figure 2: Main Markets for Lebanese Exports of Leguminous Vegetables % (2020)



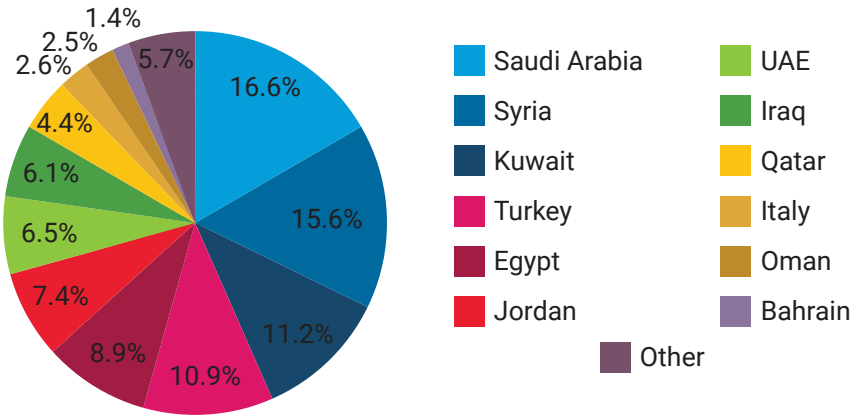
Source: ITC Trade Map

Figure 3: Main Market for Lebanese Exports of Dried Vegetables % (2020)



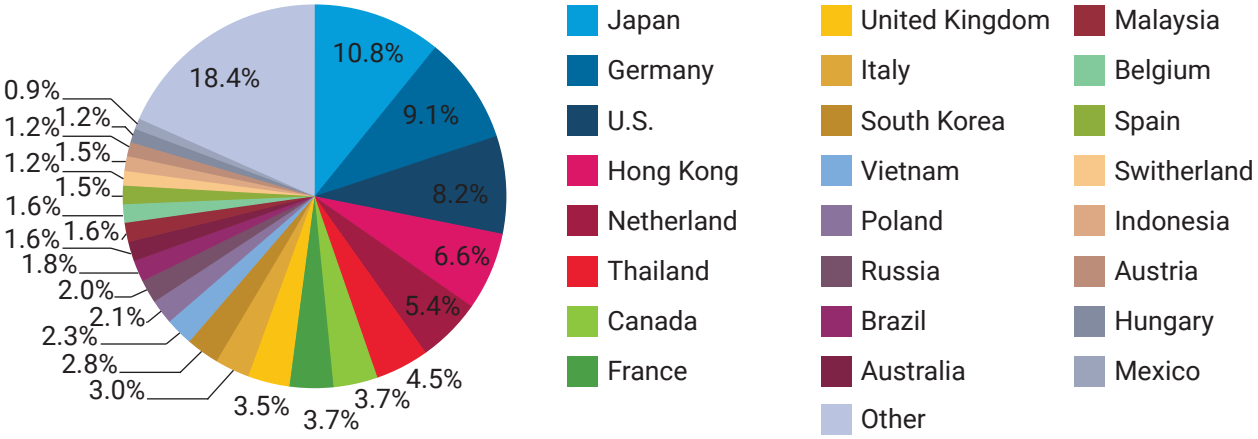
Source: ITC Trade Map

Figure 4: Main markets for Lebanese exports of Edible Fruits and Nuts %(2020)



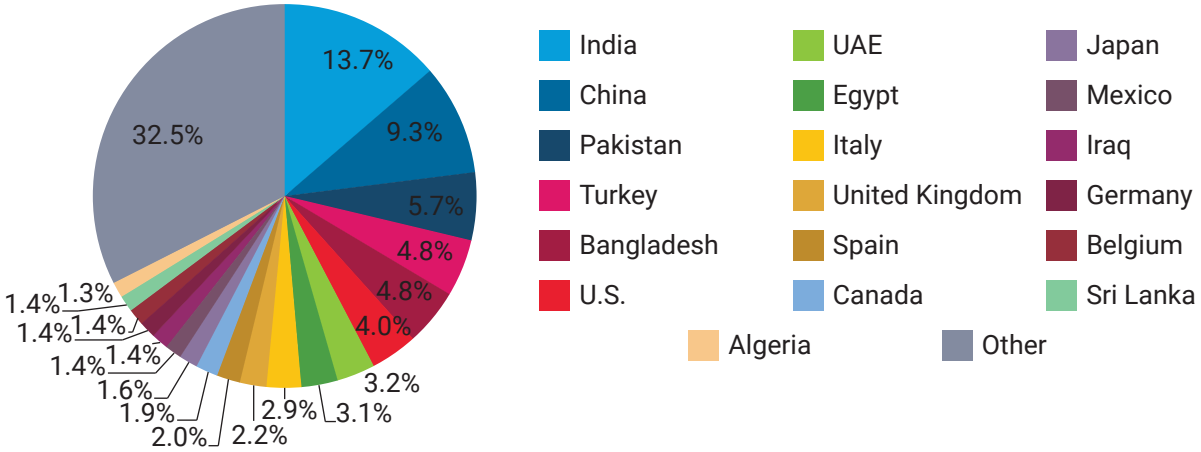
These segment (HS 08) include dried fruits and nuts, among other fresh products
Source: ITC Trade Map

Figure 5: Main importers of dried vegetables % (2020)



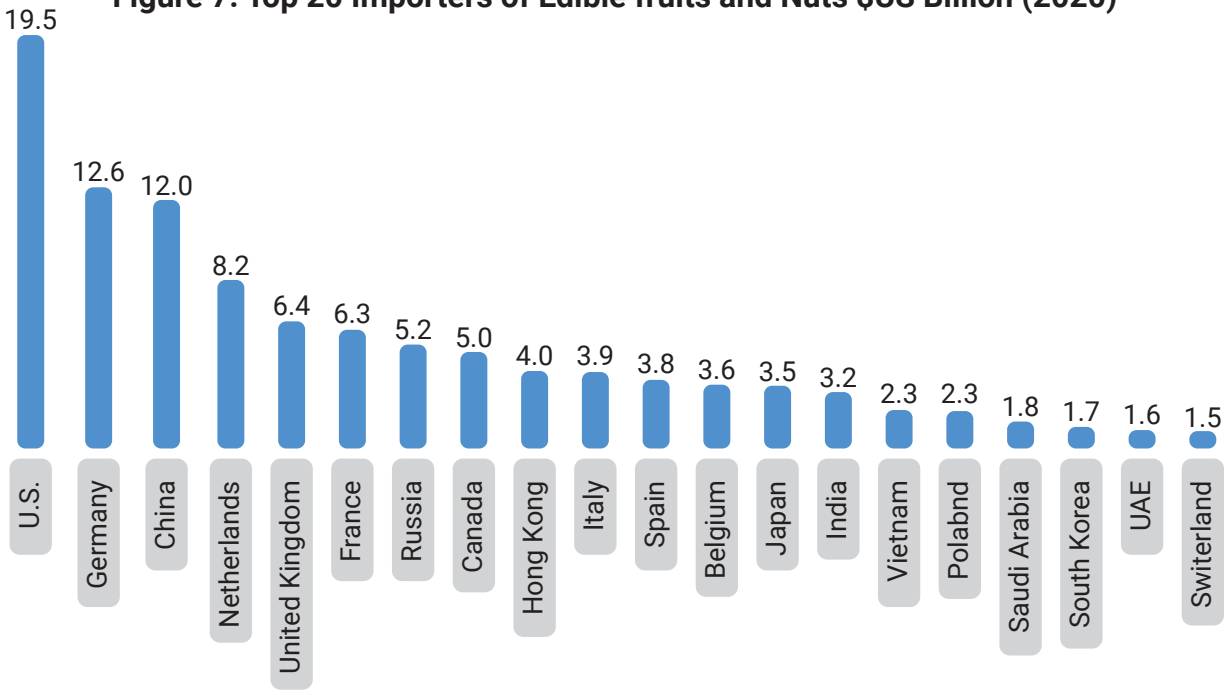
Source: ITC Trade Map

Figure 6: Main importers of dried leguminous vegetables % (2020)



Source: ITC Trade Map

Figure 7: Top 20 Importers of Edible fruits and Nuts $US Billion (2020)



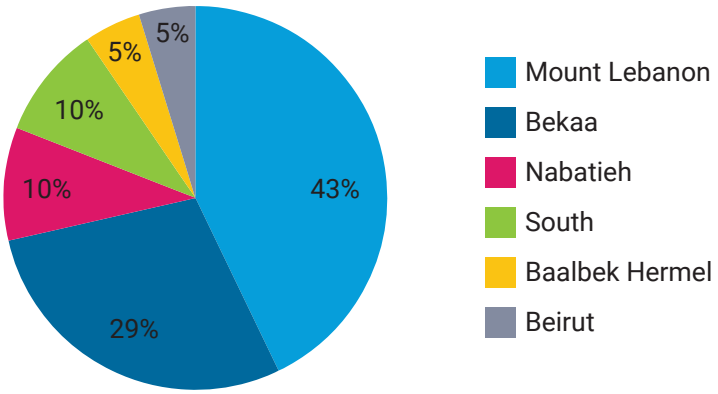
Source: ITC Trade Map

The main producers of edible fruits and nuts in the Mediterranean region and among Arab countries are Spain, Turkey, Italy, France, Morocco, Egypt, Greece, Tunisia and Saudi Arabia.

III- Supply of Dried Fruits and Vegetables in Lebanon

There are currently 21 companies producing dried fruits and vegetables registered at the Ministry of Industry.

Figure 8: Distribution of producers across governorates % (2020)



In addition, a main producer of dried fruits and vegetables in Lebanon is the cooperatives sector. In terms of nuts, there are around 100 roasteries in Lebanon, of which about 50% are located in Mount Lebanon and 24% in the Bekaa.[10]

The production of dried fruits and vegetables in Lebanon is expected to increase as the transformation of agricultural products from their initial form extends their shelf life, making it easier to export such products, given the current challenges in exporting fresh produce abroad.

In addition, as more people become aware of the benefits of healthy foods, snacks and diets in Lebanon, the consumption of dried fruits and vegetables will increase, pushing the local production of these products upwards.

[10]Agri-food Sector in Lebanon 2020 Factbook, IDAL

MEANS OF PRODUCTION

I- Cost Breakdown

Raw materials and energy tend to be the largest cost centers, followed by salaries and packaging.[11] Locally sourcing of raw materials, especially in terms of vegetables and fruits that could contribute to the lowering of raw material costs. Also, reducing transportation costs by carefully choosing suppliers of fruits and vegetables, or by choosing the best location based on the location of the crops needed, provided earlier by the Ministry of Agriculture. Producers can also improve their energy mix, or choose an efficient combination between conventional energy sources and renewables in order to lower the dependency on hydrocarbons, which could lower the energy bill on the long term.

II- Plant Facilities and Operating Requirements

Dried fruits and vegetables 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 Minister of Industry 1/1 dated on 5/1/2015 (General requirements in food processing establishments).

1. Location, Size and Sanitary Design.

The building and surrounding area should be such as can be kept reasonably free of objectionable odours, smoke, dust, or other contamination; should be of sufficient size for the purpose intended without crowding of equipment or personnel; should be of sound construction and kept in good repair; should be of such construction as to protect against the entrance or harbouring of insects or birds or vermin; and should be so designed as to permit easy and adequate cleaning. In areas experiencing high concentrations of air-borne pollutants, equipment should be used to remove pollutants from the air blown across or through the product.

2. Sanitary Facilities and Controls

- **Separation of processes.** Areas where raw materials are received or stored should be separated from areas in which final product preparation or packaging is conducted as to preclude contamination of the finished product. Areas and compartments used for storage, manufacture or handling of edible products should be separate and distinct from those used for inedible materials. The food handling area should be completely separated from any part of the premises used as living quarters.

[11]Information provided through interviews with companies operating in the business

- **Water supply.** An ample supply of cold water should be available and an adequate supply of hot water where necessary. The water supply should be of potable quality. Standards of potability shall not be less than those contained in the "International Standards for Drinking Water", World Health Organization, 1971.

- **Ice.** Ice should be made from water of potable quality and should be manufactured, handled, stored and used, so as to protect it from contamination.

- **Auxiliary water supply.** Where non-potable water is used - for such purposes as fire control - it must be carried in completely separate lines, identified preferably by color and with no cross-connection or back-siphonage with the lines carrying potable water.

- **Plumbing and waste disposal.** All plumbing and waste disposal lines (including sewer systems) must be large enough to carry peak loads. All lines must be water-tight and have adequate traps and vents. Disposal of waste should be effected in such a manner as not to permit contamination of potable water supplies. The plumbing and the manner of waste disposal should be approved by the official agency having jurisdiction.

- **Lighting and ventilation.** Premises should be well lit and ventilated. Special attention should be given to the venting of areas and equipment producing excessive heat, steam, obnoxious fumes or vapours, or contaminating aerosols. Good ventilation is important to prevent both condensation (which may drip into the product) and mould growth in overhead structures - which growth may fall into the food. Light bulbs and fixtures suspended over food in any step of preparation should be of the safety type or otherwise protected to prevent food contamination in the case of breakage.

- **Toilet-rooms and facilities.** Adequate and convenient toilets should be provided and toilet areas should be equipped with self-closing doors. Toilet rooms should be well lit and ventilated and not to be opened directly into a food handling area. They should be kept in a sanitary condition at all times. There should be associated hand-washing facilities within the toilet area and the notices should be posted requiring personnel to wash their hands after using the toilet.

- **Hand-washing facilities.** Adequate and convenient facilities for employees to wash and dry their hands should be provided wherever the process demands. They should be in full view of the processing floor. Single-use towels are recommended, where practicable, but otherwise the method of drying should be approved by the official agency having jurisdiction. The facilities should be kept in a sanitary condition at all times.

3. Equipment and Utensils

- **Materials.** All food contact surfaces should be smooth; free from pits, crevices and loose scale; non-toxic; unaffected by food products; and capable of withstanding repeated exposure to normal cleaning; and non-absorbent unless the nature of a particular and otherwise acceptable process renders the use of a surface, such as wood, if necessary.

- **Sanitary design**, construction and installation. Equipment and utensils should be so designed and constructed in preventing hygienic hazards and permitting easy and thorough cleaning. Stationary equipment should be installed in such a manner to permit easy and thorough cleaning.

- **Equipment and Utensils.** Equipment and utensils used for inedible or contaminating materials should be so identified and should not be used for handling edible products.

- **Drying equipment.** Equipment used for drying should be so constructed and operated that the product cannot be adversely affected by the drying medium.

4. Hygienic Operating Requirements

While additional and more specific requirements may be established for certain products, the following should apply as minimal in all food production, handling, storage and distribution:

- **Sanitary maintenance of plant,** facilities and premises. The building, equipment, utensils and all other physical facilities of the plant should be kept in a good repair, kept clean and maintained in an orderly, sanitary condition. Waste materials should be frequently removed from the working area during plant operation and adequate waste receptacles should be provided. Detergents and disinfectants employed should be appropriate to the purpose and should be used with no hazard to public health.

- **Vermin Control.** Effective measures should be taken to protect against the entrance and the harbourage on the premises of insects, rodents, birds or other vermin.

- **Exclusion of domestic animals.** Dogs, cats and other domestic animals, should be excluded from areas where food is processed or stored.

- **Personnel health.** Plant management should advise personnel that any person afflicted with infected wounds, sores, or any illness, notably diarrhea, must immediately report to management. Management should take care to ensure that no person, while known to be affected with a disease capable of being transmitted through food, or known to be a carrier of such disease microorganisms, or while afflicted with infected wounds, sores, or any illness, is permitted to work in any area of a food plant in a capacity in which there is a likelihood of such person contaminating food or food contact surfaces with pathogenic organisms.

- **Toxic substances.** All rodenticides, fumigants, insecticides or other toxic substances should be stored in separate locked rooms or cabinets and handled only by properly trained personnel. They should be used only by or under the direct supervision of personnel with a thorough understanding of the hazards involved, including the possibility of contamination of the product.

5. Personnel Hygiene and Food Handling Practices

- All persons working in a food plant should maintain a high degree of personal cleanliness while on duty. Clothing including suitable headdress should be appropriate to the duties being performed and should be kept clean.

- Hands should be washed as often as necessary to conform to hygienic operating practices.

- Spitting, eating and the use of tobacco or chewing gum should be prohibited in food handling areas.

- All necessary precautions should be taken to prevent the contamination of the food product or ingredients with any foreign substance.

- Minor cuts and abrasions on the hands should be appropriately treated and covered with a suitable waterproof dressing. Adequate first-aid facilities should be provided to meet these contingencies to prevent contamination of the food.

- Gloves used in food handling should be maintained in a sound, clean and sanitary condition; gloves should be made of an impermeable material except where their usage would be inappropriate or incompatible with the work involved.

III. Operating Practices and Production Requirements

Raw material handling

- **Acceptance criteria.** The raw material should not be accepted by the plant if known to contain decomposed, toxic or extraneous substances which will not be removed to acceptable levels by normal plant procedures of sorting or preparation.

- **Storage.** Raw materials stored on the plant premises should be maintained under conditions that will protect against contamination and infestation and minimize deterioration.

- **Water.** Water used for conveying raw materials into the plant should be from such a source or suitably treated as not to constitute a public health hazard.

- **Inspection and sorting.** Prior to introduction into the processing line, or at a convenient point within it, raw materials should be inspected, sorted or culled as required to remove unfit materials. Such operations should be carried out in a clean and sanitary manner. Only clean, sound materials should be used in further processing.

- **Washing or other preparation.** Raw materials should be washed as needed to remove soil or other contamination. Water used for such purposes should not be recirculated unless suitably treated to maintain it in a condition as it will not constitute a public health hazard. Water used for washing, rinsing, or conveying final food products should be of potable quality.

- **Preparation and processing.** Preparatory operations leading to the finished product and the packaging operations should be so timed as to permit expeditious handling of consecutive units in production under conditions which would prevent contamination, deterioration, spoilage, or the development of infectious or toxigenic microorganisms.

IV. Pretreatments

Methods of preservation or treatment of the finished product should be applied to kill any insects or mites remaining after processing and to result in protection against contamination, deterioration, or development of a public health hazard. The finished product should be of such moisture content that it can be held in the localities of origin and distribution under any normally foreseeable conditions for those localities without significant deterioration by decay, mould, enzymatic changes, or other causes.In addition to applicable drying, the finished product may be treated with chemical preservatives at levels approved by the Codex Alimentarius Commission, as referenced in

the Codex Commodity standards, heat processed and/or packed in hermetically sealed containers so that the product will remain safe and will not be spoiled under normal non-refrigerated storage conditions.[12]

Pretreatments are recommended techniques used to make quality products especially for fruits. Pretreatments not only prevent darkening and improving quality; but also cause the destruction of pathogens that could cause foodborne illness—such as *Escherichia coli O157:H7, Salmonella species and Listeria monocytogenes.*

Pretreatments include dipping, blanching, cooking or candying.

- **Dipping** prevents oxidation or color changes in fruits and vegetables. Dipping fruits in ascorbic acid (vitamin C) is one of the safest ways to prevent fruit from turning brown, but its effects may not last as long as sulfuring. Ascorbic acid can be purchased from drug or grocery stores, in powder or tablet form. One teaspoon is equal to 3,000 milligrams in tablet form. Mix 1 teaspoon in 2 cups of water. Allow the fruit to soak for 3–5 minutes, then drain well and place on dryer trays. After two "dips" with produce, add more acid to continue the effectiveness.

Note
Fruit juices can also be used. Dip fruits in pineapple or orange juice or other high vitamin C fruit. Remember each fruit will also lend its flavor as fruits soak for 3–5 minutes. Drain well and place on dryer trays. Use twice before placing, and the juice is still safe to be used in other drinks or recipes. ***Sodium sulfite*** is another commercial product for pretreating foods. Sodium metabisulfite is available at many wines supply shops or some pharmacies. Stir 1 tablespoon of sodium metabisulfite into 1 quart of cold water. Allow fruit to soak 10–15 minutes, then drain and place on dryer trays. This solution is only good for one dip; remake for more than one use.

- **Steam blanching** can be used, but the flavor and texture of the fruit might change. This process is the same as for vegetables. Bring water to a boil. Place produce in a basket not over 2 inches deep, over the boiling water. Cover tightly with a lid and blanch according to Table below.

- **Blanching** is recommended for vegetables, as it stops the enzyme action that controls the color and flavor during storage. It also helps to decrease the drying time and cooking time at the other end because the tissue walls of the produce have been relaxed and moisture can escape and re-enter more easily. Boiling water blanching or steam blanching are both effective, but steam blanching is more time consuming.

[12]CODE OF HYGIENIC PRACTICE FOR DRIED FRUITS

Steam blanch vegetables as below, but do not submerge; the water should not come into contact with the product. Cover and steam according to Table 1. Only steam blanch small amounts at a time.

Drying Table		
Food	Preparation for Drying	Dryness Test
Fruits		
Apples	Pare, core and cut into 0.6 cm slices or rings. Pretreat dipping for 2 minutes.	Pliable, springy feel, creamy white. No moist area when cut.
Bananas	Peel, cut into 0.3 cm slices. Dip in ½ cup pineapple juice mixed with ¼ cup honey.	Sticky, chewy, caramel-like color.
Berries	Leave whole, except slice strawberries in half.	No visible moisture when crushed.
Cherries (any kind)	Remove stems and pits. If juicy, drain 1 hour.	Leathery but sticky.
Grapes	Leave whole, remove stems. Dip in boiling water to crack skins.	Pliable, dark brown.
Peaches and apricots	Peel if desired, remove pits, and slice. Pretreat dipping solution.	Pliable and leathery.
Pears	Pare and remove core and woody tissue. Cut into 0.3 cm slices or rings, or into quarters or eighths. Pretreat dipping solution.	Leathery, springy feel.
Pineapple	Peel, core and slice 1.2 cm thick.	Pliable, spongy to the touch.
Plums	Same as prunes. Use freestone varieties. Pretreat.	Pliable and leathery.
Prunes	Cut in halves and remove pits or leave whole. Halves: No pretreatment. Whole: To soften and crack skins and to help fruit dry better, hold in steam or boiling water for 2 minutes.	Pliable and leathery.

Vegetables		
Beans, green and lima	Shell. Steam 15–20 minutes, or until tender but firm.	Shatters when hit.
Beans, snap	Trim and slice lengthwise (or cut in 2.5 cm pieces). Steam about 3–5 minutes, or until tender but firm. Spread about 1.2 cm deep on trays.	Brittle, dark green to brownish.
Beets	Trim off all but 2 cm of tops and roots. Steam whole about 30–60 minutes, depending on size, or until cooked through. Cool and peel. Cut in 0.6 cm cubes, or slice 0.3 cm thick. Spread not more than 0.6 cm deep on trays.	Brittle, dark red.
Broccoli	Trim, slice lengthwise in 1.2 cm strips. Steam 10 minutes or until tender but firm.	Brittle, very dark green.
Cabbage	Trim, cut into 0.3 cm thick strips. Steam 5–10 minutes, or until tender but firm. Spread evenly to a depth of not more than 2.5 cm. Pretreat with lemon juice.	Crisp, pale yellow to green.
Carrots	Scrape or peel. Slice crosswise 0.3 cm thick, or dice in 0.6 cm cubes. Steam small pieces 3 minutes (or shred before steaming). Spread in thin layer on trays.	Very brittle, deep orange.
Celery	Remove leaves, cut stalks into 1.2 cm pieces. Water blanch 1 to 2 minutes or until tender. Stir occasionally during drying.	Very brittle.
Corn	Husk and trim. Blanch whole ears 9 minutes. For medium or raw kernels, blanch 3–5 minutes. Cut corn from cob after blanching.	Shatters when hit.
Eggplant	Peel and slice 0.3 - to 0.6 cm thick. Dip in lemon juice solution for 5 minutes or steam 5 minutes (or until tender).	Leathery to brittle.

Greens	Trim off tough stems. Steam 5 minutes or until tender. Spread leaves that mat, such as spinach, about 0.6 cm deep.	Crisp, very dark green.
Mushrooms	Peel the larger mushrooms. Dry whole or slice, depending on size. No precooking necessary. If stems are tender, slice for drying; if tough, discard. Spread on trays.	Leathery to brittle.
Onions	Peel, slice into 0.3 cm rings. Blanch 1 minute. If dried for seasoning, do not steam.	Very crisp.
Peas, green	Steam shelled peas 3 minutes or until tender. Stir during drying.	Shatter when hit with a hammer.
Peppers (all kinds) and pimentos	Cut into 1.2 cm strips or rings. Remove seeds. Steam 10 minutes. Spread rings 2 layers deep; spread strips not more than 1.2 cm deep.	Pliable.
Pumpkin and winter squash	Quarter, remove seeds and pit, cut in 2.5 cm strips and peel. Slice strips crosswise 0.6 cm thick. Bake at 300°F until soft. Place in dehydrator.	Leathery.
Soybeans, edible green	Blanch pods in steam 10–15 minutes, or until beans are tender but firm. Shell.	Shatter when hit.
Squash, summer and zucchini	Trim, slice 0.6 cm thick without peeling and steam 6 minutes or until just tender. Pretreat optional.	Leathery to brittle, yellow.
Tomatoes (meaty varieties only)	Dip in boiling water for 1 minute. Peel, remove stem end and slice 0.3 cm thick.	Leathery, dull red.

After blanching, cool quickly in an ice water bath; then, drain and place in a single layer on the drying tray. It's OK if the **vegetables** are still warm; that will hasten the drying process. As with **fruits**, pay attention to the end of the drying time so the product does not scorch.

Generally speaking, vegetables are great to dry because they contain less acid than fruits and can be dried until they are brittle. When properly dried, vegetables contain only **10 to 15%** moisture, and no known microorganisms can grow at that level. Wash, peel and trim produce; then, cut into pieces for drying (could be into slices, sticks, cubes or shredded), taking care to remove any tough or "woody" part of the item. Even pieces are one secret to successful drying, as all will dry at the same rate. Only prepare what can be dried at one time.

Dried fruits are generally done when they reach **a moisture content dependent on the type and mentioned in the relevant Lebanese standard/technical regulation.** Because fruit will be more pliable when warm, cool several pieces and test them, by folding the fruit upon itself; it should not stick together. Berries should rattle when stored in a container. When drying is complete, cool the fruit before storing, but don't leave out to gather additional moisture from the air. The product is then ready to be conditioned.

Dried vegetables should be crisp when dried and should "snap" when broken in two. At this stage of moisture, no conditioning is needed.

If food was dried outdoors, which is not recommended for mainly health reasons, there could be eggs on the food from insects that touched the food during drying. To pasteurize and kill the eggs post-drying: either place food in a freezer bag and freeze for 48 hours or heat the dried food at 65°C for 30 minutes or 80°C for 15 minutes. Be careful not to scorch the food.
Dried vegetables should be crisp when dried and should "snap" when broken in two. At this stage of moisture, no conditioning is needed.

After drying, conditioning of dried foods is the last step before final storage.

For fruit, place the cooled product in a tightly sealed glass jar, shaking daily for 7–10 days. If condensation develops, return to the dehydrator for more drying. Package dried food for long-term storage after conditioning for 10 days. Remember to keep food with high vitamin A or C out of direct sunlight during storage.

V. Drying Technologies

Sun Drying

The high sugar and acid content of fruits make them safe to dry in the sun. Vegetables are not recommended for sun drying. Vegetables are low in sugar and acid. This increases the risks for food spoilage. To dry in the sun, hot, dry, breezy days are best. A minimum temperature of 30 C is needed with higher temperatures being better. It takes several days to dry foods outdoors. Because the weather is uncontrollable, sun drying can be risky. Also, the high humidity in the South is a problem. Humidity below 60 percent is best for sun drying. Often these ideal conditions are not available when fruit ripens. Fruits dried in the sun are placed on trays made of screen or wooden dowels. Screens need to be safe in contact with food. The best screens are stainless steel, Teflon coated fiberglass or plastic. Avoid screens made from “hardware cloth”, which is galvanized metal cloth that is coated with cadmium or zinc. These materials can oxidize, leaving harmful residues on the food. Also avoid copper or aluminum screening. Copper destroys vitamin C and increases oxidation. Aluminum tends to discolor and corrode. For outdoor drying rack, most woods are fine for making trays. However, do not use green wood, pine, cedar, oak or redwood. These woods warp, stain the food or cause off-flavors in the food. Place trays on blocks to allow for better air movement around the food. Because the ground may be moist, it is best to place the racks or screens on a concrete driveway or if possible over a sheet of aluminum or tin. The reflection of the sun on the metal covers the trays with cheesecloth to help protect the fruit from birds or insects. Fruits dried in the sun must be covered or brought under shelter at night. The cool night air condenses and could add moisture back to the food, thus slowing down the drying process.

Solar Drying or Warm Air Driers

Recent efforts to improve on sun drying have led to solar drying. Solar drying also uses the sun as the heat source. A foil surface inside the dehydrator helps to increase the temperature. Ventilation speeds up the drying time. Shorter drying times reduce the risks of food spoilage or mould growth.

Freeze Drying

Freeze-drying, also known as lyophilization, or cryodesiccation, is a dehydration process typically used to preserve a perishable material or make the material more convenient for transport, freeze-drying works by freezing the material and then reducing the surrounding pressure to allow the frozen water in the material to sublimate directly from the solid phase to the gas phase.
Freeze drying of biological materials is one of the best methods of water removal which results in final product of the highest quality. Freeze drying is sublimation of ice fraction where water passes from solid to gaseous state. Due to very low temperature all the deterioration activity and microbiological activity are stopped and provide better quality to the final product. Recently the market for organic products is increasing. Therefore, the use of freeze drying of fruits and vegetables is not only increasing in volume but also diversifying. Freeze drying seems to be better preservation method over other dehydration methods such as air or drum drying. For example, freeze drying of small fruits such as strawberry dried at 20°C retained better quality than at 60°C. The product mostly collapses i.e., loss in structure, reduction in pore size and shrinkage at higher temperature. Low processing temperature improved the sensory quality of dried fruits.

Oven Drying

Everyone who has an oven has a dehydrator. By combining the factors of heat, low humidity and air flow, an oven can be used as a dehydrator. An oven is ideal for occasional drying of fruit leathers, banana chips or for preserving excess produce like celery or mushrooms. Because the oven is needed for every day cooking, it may not be satisfactory for preserving abundant garden produce. Oven drying is slower than dehydrators because it does not have a built-in fan for the air movement. (However, some convection ovens do have a fan). It takes about two times longer to dry food in an oven than it does in a dehydrator. Thus, the oven is not as efficient as a dehydrator and uses more energy.

Osmotic Dehydration (OD)

Osmosis is known as a partial dehydration process which consists on the removal of water by immersing the food in a solution of salt or sugars with high osmotic pressure. Water is removed from the food to the solution by virtue of the difference in osmotic pressure. Although it does not remove enough moisture to be considered as a dried product, the process has the advantage of requiring little energy. It works well as a pre-treatment prior to drying by other methods. The application of OD to fruits and to a lesser extent to vegetables, has received attention in recent years as a technique for production of intermediate moisture foods or as a pre-treatment prior to drying in order to reduce energy consumption or heat damage. Multiple aspects of OD play a role in the process and the final product such as:

- Temperature and concentration.
- Sample to solution ratio.
- Agitation of fruit in syrup.
- Sample size and shapes.
- Osmotic agents.
- Material type.
- Pre-treatment.

Using OD, even though the moisture loss and solids gain occurred at the same time, the rate of moisture loss is much higher than the rate of solids gain. The advantage of OD is its lower energy use and lower product thermal damage since lower temperatures allow the retention of nutrients.
The main advantages of using OD are the reduction of process temperature, sweeter taste of dehydrated product, reduction of 20–30% energy consumption and shorter drying time.
The driving force for the diffusion of water from the tissue into the solution is provided by higher osmotic pressure of hypertonic solution. The rate of mass transfer during OD is generally low. Techniques to improve mass transfer are:

1. Partial vacuum.
2. Ultra-high hydrostatic pressure.
3. High intensity electrical field pulses.
4. Ultrasound Acoustic streaming
5. Microwave Heating

1. Partial Vacuum

The reduction in pressure causes the expansion and escape of gas occluded into pores. When the pressure is restored, the pores can be occupied by the osmotic solution, increasing the available mass transfer surface area which will lead to an increase in loss of water. Vacuum pressure (50-100 mbar) is applied to the system for shorter time to achieve the desired result.

2. High hydrostatic pressure

It is observed that application of high hydrostatic pressure damages the cell wall structure which leads to significant changes in the tissue architecture, leaving the cells more permeable, resulting in increased removal of water during OD.

3. Pulsed electric field (PEF)

The PEF treatment has been reported to increase the permeability of plant cells by inducing cell damage, resulted in tissue softening, which in turn resulted in a loss of water. The increase in loss of water will improve the OD. In conclusion PEF treatment increases water loss, which is attributed to increased cell membrane permeability. Drying time of PEF-pretreated fruits and vegetables is reduced up to 25% than none treated.

4. Ultrasound Acoustic streaming

Affect the thickness of boundary layer which exists between stirred fluid and solid. Cavitation of bubbles in the liquid which can collapse and generate localized pressure fluctuation. This ultimately increases the mass transfer of osmotic treatment.

5. Microwave heating

Microwave heating generates heat within the material and heats the entire volume at about the same rate. Microwave technology can be combined with conventional heating and drying units and is easily automated. The overall ratio of moisture loss to solid gain is higher in microwave assisted OD than in conventional OD.

Microwave Drying

Microwave drying uses electrical energy in the frequency range of 300 MHz to 300 GHz, with 2,450 MHz being the most commonly used frequency. The use of microwave energy for drying has been demonstrated to have a moderately low energy consumption. Since microwaves alone cannot complete a drying process, it is recommended to combine techniques, such as forced air or vacuum, in order to further improve the efficiency of the microwave process. When the material couples with microwave energy, heat is generated within the product through molecular excitation. The critical next step is to immediately remove the water vapor. A simple technique for removing water is to pass air over the surface of the material hence combining processes to form what is called “microwave convective drying”. The air temperature passing through the product can be varied to shorten the drying time. In order to control the product’s temperature, either power density (Watts/g of material) or duty cycle (time of power on/off) must be controlled. Use of microwave energy in drying, offers reduced drying times and complements conventional drying in later stages by specifically targeting the internal residual moisture. Good quality dried products can be achieved by varying power density and duty cycle time. Quality improvement are found in color, shrinkage and rehydration property. The quality of dried fruits by microwave is superior to hot air-dried samples in color, damage, darkness, crystallized sugar, stickiness and uniformity.

Superheated Steam Drying

Drying with superheated steam (SS) in the absence of air in a medium composed entirely of steam. The ability of SS to dry food material is due to the addition of sensible heat to raise its temperature above the corresponding saturation temperature at a given pressure. It is not necessary to exhaust the evaporated water from the produce until the pressure develops beyond certain limit. After that excess steam will be released. The great advantage is that recycling of drying method is possible, provided additional sensible heat is added. Besides, any conventional convection and conduction dryer could be easily converted to use superheated steam. SS drying could be effectively used for many products like corn starch, potato starch and for making other by products. However, particles that are too large or fine produces are impossible to dry in a fluidized bed.

Superheated steam drying uses the following principles:

- Condensation of water vapor on samples occurs below the boiling point of water.
- All of the heat transferred into the sample surface is used for evaporation when the sample temperature is equal to the boiling point.
- Boiling point of water changes the pressure in the local point of sample.
- Overall heat transfer coefficient on the sample surface includes thermal radiation from the drying medium.
- Drying process is complete when the temperature of sample is higher than the boiling point of water.

Spray Drying (SD)

The SD is a well-known industrial technology used extensively on a large scale for drying and powdering heat sensitive materials from liquid foods. The overall objective in SD is to get the most rapid liquid removal with minimal negative impact on the product, without damaging the surrounding environment at the lowest capital and operating costs. By using heat, SD efficiently transforms a dilute fluid suspension into a dry powder and renders good quality to final powder. SD process comprises of 4 basic steps:

- Atomization.
- Contact between drop lets and hot gas.
- Water evaporation.
- Gas-powder separation.

Uniformity of drop size and homogeneity of spray jet are important considerations in designing nozzle. Pneumatic two-fluid nozzle, pressure nozzle and cone nozzle are most commonly used. Drying through SD may either in single stage, 2 or 3 stages. Pneumatic nozzle type driers mostly worked with single stage drying. Two-stage system comprises of the spray dryer followed by a vibro-fluidized bed system. Three stage processes improve the properties of dried powder by instant reconstitution because the fluid bed works as a dryer-agglomerator, controlling particle agglomeration.

Vacuum drying

Vacuum drying is an important process for heat sensitive materials. The process of vacuum drying can be considered according to physical condition used to add heat and remove water vapor. Low temperature can be used under vacuum for certain methods that might discolor or decompose at high temperature. A comparison of drying technologies showed that freeze drying, vacuum drying and osmotic dehydration are considered too costly for large scale production of commodity.
Batch vacuum dryers are substantially the same as tray dryers, except that they operate under a vacuum, and heat transfer is largely by conduction or by radiation. The trays are enclosed in a large cabinet, which is evacuated. The water vapor produced is generally condensed, so that the vacuum pumps have only to deal with non-condensable gases. Another type consists of an evacuated chamber containing a roller dryer.

Hybrid drying

Hybrid drying techniques are becoming common since the combined technology receives the benefits of individual process. The number of combinations possible is vast and as technology continues to improve more will be developed. Adding a microwave system to a spouted bed system combines the benefits offered by each technology. The microwave action decreases drying time while the fluidization produced by the spouting system improves drying uniformity, thus reducing the burning. Thermal-vacuum dryer intended for drying agricultural products can be manufactured with cheap and widely used materials such as wood or plastic. A study showed the combination of hot air drying and freeze drying increased the quality of dehydrated fruits and vegetables. The drying time and total energy consumption were favorably 50% lower than freeze drying alone. High initial cost, loss of aroma, and degradation of texture are some of the disadvantages of microwave drying. Combination drying with an initial conventional drying process followed by a finish microwave or microwave vacuum process has proven to reduce drying time while improving product quality and minimizing energy requirements.

VI. Equipment

Equipment used in the process of drying fruits and vegetables are:

1. **Cleaner**
2. **Blanchers**
3. **Chopper**
4. **Dryers**

1. Cleaner

It is important to wash thoroughly and clean the fruits and vegetables that will be dried, to ensure that no precipitations are present on them.

Currently, there are many different types of fruit washing machine, such as mesh belt bubble washer, brush and spray washer, high-pressure surfing washer, ultrasonic cleaner.

2. Blanchers

Blanching is a process used as a pre-treatment in the food industry. Fruits and vegetables are blanched to inactivate enzymes that cause deterioration in color and flavor during drying and subsequent storage. Blanching may be carried out using water or steam.

The blanching time is very important and varies with the vegetable type and size.

- Under blanching stimulates the activity of enzymes and is worse than no blanching.
- Over blanching causes loss of flavor, color, vitamins and minerals.

The Tables below highlights the most common fruits and vegetables and their respective blanching times:

Fruit	Method	Time (Min)
Apple	Water	10.0
	Steam	3.0 - 5.0
Apricot	Water	10.0
	Steam	3.0 - 4.0
Banana	Water	10.0
	Steam	3.0 - 4.0
Cherry	Water	10.0
Figs	Not needed	-
Grape	Not needed	-
Nectarine	Water	10.0
	Steam	8.0
Peach	Water	10.0
	Steam	8.0
Pear	Water	10.0
	Steam	6.0
Pineapple	Not needed	-
Plum	Not needed	-

Vegetable	Method	Time (Min)
Carrot	Water	3.5
	Steam	3.0 - 3.5
Corn	Not needed	-
Garlic	Not needed	-
Horseradish	Not needed	-
Mushroom	Not needed	-
Orca	Not needed	-
Onion	Not needed	-
Parsley	Not needed	-
Pea	Water	2.0
	Steam	3.0
Pepper	Not needed	-
Potato	Water	5.0 - 6.0
	Steam	6.0 - 8.0
Pumpkin	Water	2.5 - 3
	Steam	1.0

3. Chopper

The usage of a chopper for the fruits and vegetables is very important since it will reduce the mass that needs drying and the time, shape and size of the chopped fruits and veggies are linked to their type mainly, other specification can play a role such as the percentage of water and the shape of the fruit.

4. Dryers

Machines that use different techniques to remove moisture by applying excessive heat and ventilation. Depending on the method used it can be distinguished the following type of driers:

a. Tray Dryers
b. Tunnel Dryers
c. Roller or Drum Dryers
d. Fluidized Bed Dryers
e. Spray Dryers
f. Pneumatic Dryers
g. Rotary Dryers
h. Trough Dryers
i. Bin Dryers
j. Belt Dryers
k. Freeze Dryers

a. Tray Dryers

In tray dryers, the food is spread out, generally quite thinly, on trays in which the drying takes place. Heating may be by an air current sweeping across the trays, by conduction from heated trays or heated shelves on which the trays lie, or by radiation from heated surfaces. Most tray dryers are heated by air, which also removes the moist vapors.

b. Tunnel Dryers

These may be regarded as developments of the tray dryer, in which the trays on trolleys move through a tunnel where the heat is applied and the vapors removed. In most cases, air is used in tunnel drying and the material can move through the dryer either parallel or counter current to the air flow. Sometimes the dryers are compartmented, and cross-flow may also be used.

c. Roller or Drum Dryers

In these types of dryers, the food is spread over the surface of a heated drum. The drum rotates, with the food being applied to the drum at one part of the cycle. The food remains on the drum surface for the greater part of the rotation, during which time the drying takes place, and is then scraped off. Drum drying may be regarded as conduction drying.

d. Fluidized Bed Dryers

In a fluidized bed dryer, the food material is maintained suspended against gravity in an upward-flowing air stream. There may also be a horizontal air flow helping to convey the food through the dryer. Heat is transferred from the air to the food material, mostly by convection.

e. Spray Dryers

In a spray dryer, liquid or fine solid material in a slurry is sprayed in the form of a fine droplet dispersion into a current of heated air. Air and solids may move in parallel or counter flow. Drying occurs very rapidly, so that this process is very useful for materials that are damaged by exposure to heat for any appreciable length of time. The dryer body is large so that the particles can settle, as they dry, without touching the walls on which they might otherwise stick. Commercial dryers can be very large of the order of 10 m diameter and 20 m high.

f. Pneumatic Dryers

In a pneumatic dryer, the solid food particles are conveyed rapidly in an air stream, the velocity and turbulence of the stream maintaining the particles in suspension. Heated air accomplishes the drying and often some form of classifying device is included in the equipment. In the classifier, the dried material is separated, the dry material passes out as product and the moist remainder is recirculated for further drying.

g. Rotary Dryers

The foodstuff is contained in a horizontal inclined cylinder through which it travels, being heated either by air flow through the cylinder, or by conduction of heat from the cylinder walls. In some cases, the cylinder rotates and in others the cylinder is stationary and a paddle or screw rotates within the cylinder conveying the material through.

h. Trough Dryers

The materials to be dried are contained in a trough-shaped conveyor belt, made from mesh, and air is blown through the bed of material. The movement of the conveyor continually turns over the material, exposing fresh surfaces to the hot air.

i. Bin Dryers

In bin dryers, the foodstuff is contained in a bin with a perforated bottom through which warm air is blown vertically upwards, passing through the material and so drying it.

j. Belt Dryers

The food is spread as a thin layer on a horizontal mesh or solid belt and air passes through or over the material. In most cases the belt is moving, though in some designs the belt is stationary and the material is transported by scrapers.

k. Freeze Dryers

In freeze driers, the material is held on shelves or belts in a chamber that is under high vacuum. In most cases, the food is frozen before being loaded into the dryer. Heat is transferred to the food by conduction or radiation and the vapor is removed by vacuum pump and then condensed. In one process, given the name accelerated freeze drying, heat transfer is by conduction; sheets of expanded metal are inserted between the foodstuffs and heated plates to improve heat transfer to the uneven surfaces, and moisture removal. The pieces of food are shaped so as to present the largest possible flat surface to the expanded metal and the plates to obtain good heat transfer. A refrigerated condenser may be used to condense the water vapor.

VI. Packaging and Storing Dried Foods

Packaging materials should be stored in a clean and sanitary manner and should not transmit to the product objectionable substances beyond acceptable limits and should provide appropriate protection from contamination.

Dried foods are susceptible to insect contamination and moisture reabsorption and must be properly packaged and stored. First, cool completely. Warm food causes sweating which could provide enough moisture for mold to grow. Pack foods into clean, dry, insect-proof and food grade containers as tightly as possible without crushing. These containers could be dry home canning jars, plastic freezer containers with tight-fitting lids or plastic freezer bags.

Vacuum packaging is also a good option. Pack foods in amounts that can be used all at once. Each time a package is re-opened, the food is exposed to air and moisture that can lower its quality and result in spoilage.

Pack food in amounts that will be used in a recipe. Every time a package is re-opened, the food is exposed to air and moisture that lower its quality.

Fruit that has been sulfured should not touch metal. Place the fruit in a plastic bag before storing it in a metal can. Sulfur fumes will react with the metal and cause color changes in the fruit.

VII. Storage and Transport of Finished Products

The finished products should be stored and transported under such conditions as will preclude the contamination with or development of pathogenic or toxicogenic microorganisms and protect against rodent and insect infestation and deterioration of the product or of the container.

(a) The product should be stored under suitable conditions of time, temperature, humidity, and atmosphere, to prevent significant deterioration.

(b) Where dried fruits are stored under conditions in which they may become infested by insects and mites, appropriate methods of protection should be used regularly. Dried fruits should be stored in such a manner, that they can be fumigated in situ or so stored that they can be removed elsewhere for fumigation in special facilities (e.g., fumigation chambers, steel barges, etc.). Cold storage can be used, either to prevent infestation in localities where insects are likely to be present in ordinary storage or to prevent insects damaging the fruit[13]. Recommended storage times for dried foods range from 4 months to 1 year. Because food quality is affected by heat, the storage temperature helps determine the length of storage; the higher the temperature, the shorter the storage time will be. Most dried fruits can be stored for 1 year at 16°C, 6 months at 26°C Vegetables have about half the shelf-life of fruits.

Foods that are packaged seemingly "bone dry" can be spoiled if moisture is reabsorbed during storage. Check dried foods frequently during storage to see if they are still dry. Glass containers are excellent for storage because any moisture that collects on the inside can be seen easily. Foods affected by moisture, but not spoiled, should be used immediately or dried again and repackaged. Mouldy foods should be discarded.

CONDITIONING FRUITS

When the fruit is taken from the dehydrator, the remaining moisture may not be distributed equally among the pieces because of their size or their location in the dehydrator. Conditioning is the process used to equalize the moisture. It reduces the risk of mould growth.

To condition the fruit, take the dried fruit that has cooled and pack it loosely in plastic or glass jars. Seal the containers and let them stand for 7 to 10 days. The excess moisture in some pieces will be absorbed by the drier pieces. Shake the jars daily to separate the pieces and check the moisture condensation. If condensation develops in the jar, return the fruit to the dehydrator for more drying. After conditioning, package and store the fruit as described above.

[13]CODE OF HYGIENIC PRACTICE FOR DRIED FRUITS (CAC/RCP 3-1969)

VIII. Labelling

All dried fruits and vegetables must be labeled properly with an approved label which states a descriptive name of the product, the contact information and location of the producer, the production date, the expiry date, and the traceability code, the ingredient list in descending order of weight, the net quantity in metric units, and the declaration of food allergens.

If Allergens, the sulfite dip is used to reduce browning of dried fruit, the mandatory standard NL 206:2017 requires this statement “contains added sulfites” only if the detectable amount of sulfating agent is 10 parts per million or more of the sulfites in the finished food.

INNOVATION

A. Fruit Leather

Leathers From Fresh Fruit

Select ripe or slightly overripe fruit. Wash fresh fruit or berries in cool water. Remove peel, seeds and stem. Cut fruit into chunks. Use 2 cups of fruit for each 30 cm by 38 cm fruit leather. Puree fruit until smooth. To prevent darkening, add 2 teaspoons of lemon juice or ⅛ teaspoon ascorbic acid (375 milligrams) for each 2 cups of light-colored fruit.

If you choose to sweeten the leather, add corn syrup, honey or sugar. Corn syrup or honey is best for longer storage because they do not crystallize. Sugar is fine for immediate use or short-time storage. Use ¼ to ½ cup sugar, corn syrup or honey for each 2 cups of fruit. Saccharin-based sweeteners could also be used to reduce tartness without adding calories. Aspartame sweeteners might lose sweetness during drying.

Leathers From Canned or Frozen Fruit

Home-preserved or store-bought canned or frozen fruit may also be used to make leathers. Drain fruit and save liquid. Use 470 ml of fruit for each 30 cm by 38 cm leather. Puree fruit until smooth; if too thick, add liquid. Add 2 teaspoons of lemon juice or ⅛ teaspoon ascorbic acid (375 milligrams) for each 2 cups of light-colored fruit to prevent darkening. Applesauce can be dried alone or added to any fresh fruit puree as an extender. It decreases tartness and makes the leather smoother and more pliable.

Preparing the Trays

For drying in the oven, a 30-cm by 38-cm cookie pan with edges works well. Line pan with plastic wrap, being careful to smooth out wrinkles. Do not use waxed paper or aluminum foil.

To dry in a dehydrator, purchase specially designed plastic sheets or line plastic trays with plastic wrap. Items placed on the trays should not touch; allow space between items for air flow. Remember to watch food more closely at the end of drying times, as the decline in moisture causes food to dry faster and may scorch.

Pouring the Leather

Fruit leathers can be poured into a single large sheet (30-cm by 38-cm) or into several smaller size pieces. Spread purée evenly, about ⅛-inch thick, onto drying tray. Avoid pouring purée too close to the edge of the cookie sheet. Larger fruit leathers take longer to dry. Approximate drying times are 6 to 8 hours in a dehydrator or up to 18 hours in an oven.

Drying the Leather

Dry fruit leathers at 60°C. Leather dries from the outside edge toward the center. Test for dryness by touching center of leather; no indention should be evident. While warm, peel leather from plastic and roll. Then, allow the leather to cool and rewrap the roll in plastic.
Chances are, the fruit leather won't last long enough for storage. If it does, it will keep up to 1 month at room temperature. For storage up to 1 year, place tightly wrapped rolls in the freezer.

B. Vegetable Powder

You can do single ingredient powders or just mix up all of the veggies and powder them such as corn, carrots, green beans, peas, potatoes, broccoli, and cauliflower. The mixture tends to take on a more neutral taste. If your ratio is heavy on a particular vegetable, it may begin to take on more of that particular flavor.

Cut your dehydrated veggies into small pieces and pour them into a blender to grind them and turn them to powder.
Strain out the powder into a bowl to take the larger bits and grind them again.
The basic ratio of vegetables to vegetable powder is this
1.5-2 Cup of vegetables to 1 Cup of dehydrated vegetables to ½ Cup vegetable powder.

The ratio will vary depending on the cut of the vegetables (these were small cut sizes). 1 Cup of uncut broccoli will be different than 1 Cup of small, chopped broccoli. This is an instance where the ratios don't have to be exact. It is to give you a sense of the conversion that you can adjust to your own taste preferences.

Add veggie powder to boost the nutrition of anything that you are making. While 1 TB of ground dried vegetables seems pointless in one instance, the accumulation of the addition of the powders to your daily life adds that much of nutrition throughout your day.

Store in an airtight container. A mason jar, a Mylar storage bag, but not zip-top plastic bags as they do allow air to permeate over time. You want to make sure that no air/moisture gets into your powder to allow it to clump or degenerate. Store in a cool, dry, dark place.
Generally, powders are freshest 6-9 months. If you can open a jar and readily identify it by smell, it's still good. If you have a hard time identifying it or you've noticed it is losing its color, it's time to use it quickly and make more.

Usage of vegetable powder:

- 1 TB to baked goods, you might not really taste it, but it helps make those brownies or cookies a little more nutritious.
- 1.5 TB into scrambled eggs
- Smoothies
- 1-2 TB into bread
- Sprinkle on salads
- Make your own vegetable capsules
- Create your own seasoning blends with herbs and spices
- Use powders to naturally color pasta
- Mix with stock and milk to make a cream of vegetable soup

N.B.:
Remember, these ratios are suggestions only. You may find you need to adjust them for your taste buds or for a particular dish.

Dried Fruits Powder
Creating fruit powder from dehydrated fruit or fruit leathers, by:

- Dry fruit completely using a dehydrator.
- Use a high-powered blender, a bullet-type blender, or even a coffee grinder to blend into a powder.
- Sift powder with a fine mesh strainer in case of lumps and seeds
- Repeat if necessary.
- Store in an airtight container, use desiccant packs if desired.

Additional Tips:

- If using fruit leather to make a powder, tear it into small pieces before starting the process
- Remember that fruit powder does have all the sugar that is in fruit. If there is a diet that requires restricted sugar intake, keep that in mind.
- Don't have fruits in season to powder, try powdering freeze-dried fruits.

Main Usage

Fruit powders can be used in so many ways to extend flavor and nutrition to everyday foods. The intensifying flavor of fruit powder can be added to:

- **Oatmeal:** sprinkle on top of oatmeal. One of the most used is apple powder.
- **Yogurt:** mix with plain yogurt for color change and added flavor.
- Flavored Milk: add to milk to change color and flavor.
- **Cereal:** adding a little extra fruit powder to cereal can give a new flavor profile to bland cereals.
- **Granola:** add fruit powder to create a new flavor profile. Apple cinnamon granola with added apple powder gives a nice sweetness with an intense apple flavor. Add some coconut powder and dried mango to a granola mix for a tropical flavor
- **Salad Dressing:** mix into homemade salad dressings for a fruity twist on salads of all kinds.

Also, powder fruits can be added into a baked item with a little extra moisture as the powder will use some to hydrate itself.

- Quick Bread: add an extra burst of flavor in quick breads by including fruit powders instead of more bulk.
- Pancakes: Extend the nutrition of a favorite pancakes' recipe like dessert pancakes, crepes, waffles, etc.
- Muffins & Scones: As with quick breads, add an extra burst of flavor with the favorite mixes to bring extra flavor without creating extra bulk.

TIP: You can also add vegetable powder to breads and batters, experiment with quantities by adding just a tablespoon to a recipe (which equals about ½ Cup vegetables), and increase as desired.

Snacks

- **Granola Bars:** when making granola bars or energy bites, add a little fruit powder to the mix, or sprinkle on top for some added flavor.
- **Marshmallows:** in making homemade marshmallows, use fruit powders to color and add flavor without adding extra fruit bulk. Taking a huge step up - dehydrate marshmallows, powder, and mix with a little fruit powder as desired, to add to hot chocolate or sprinkle on cupcakes.
- **Dehydrated Fruit Chips:** sprinkle a companion flavor onto fruit chips to create new flavor profiles.
- **Yogurt Drops:** make your own flavored yogurt drops
  - o Add 1 tablespoon of fruit powder to 1 cup of favorite plain yogurt (adjust to the taste).
  - o Line dehydrator trays with reusable silicone sheets or parchment paper (baking paper)
  - o Pipe 'dots' onto dehydrator tray using parchment paper (baking paper) or reusable silicone sheets. A zip-top bag can be used instead of piping sleeves.

- Dry at 57C for 8-12 hours until crispy. Time may vary due to the size of dots, the wattage of the machine, and relative humidity at home.
- Store in an airtight container in the fridge for 2-3 weeks.

- **Whipped Flavored Cream Cheese:** Whip the cream cheese by placing a block of softened cream cheese into a bowl and use a hand mixer or a stand mixer to whip air into it. Add fruit powder to taste and create a wonderful bagel topping or dolloped onto strawberry halves or as a spread on thinly sliced pound cake and topped with fruit.
- **Dipped pretzel rods:** mix a little of fruit powder into some melted dipping chocolate. Dip pretzel rods, garnish, and place on wax paper to dry.

Use fruit powders in these dessert items to not only change colors, but also give an intensity of flavor to them, as well.

- **Ice Cream:** top vanilla ice cream with any flavor of fruit powder to bring a new taste.
- Fruit Sugars: blend fruit powder and sugar together to create a great dusting for the tops of muffins and cupcakes.
- **Ice Cream:** mix in with the favorite ice cream recipe to intensify the flavor
- **Frosting/Icing:** mix with frosting or icing to change both the flavor and the color
- **Cake Batter:** mix with cake batters to change color or give an extra burst of flavor
- **Fruit Pops:** while making fruit pops, change the flavor up even without the particular fruit available.
- **Pie:** making pumpkin pie is super easy with pumpkin, it easily reconstitutes into a pumpkin puree with the addition of hot water.
  - Simply mix:
    - 2 Cup warm water
    - ½ Cup pumpkin powder
    - Allow to sit for 30 minutes. mix more or less to create your desired consistency
    - Pie: Use fruit powder to help thicken a pie or add more intense flavor if the fruit is not quite 'fruity' enough.
- **Whipped cream:** make a flavored homemade whipped cream with just a little bit of fruit powder.

Dry rubs and seasoning blends can elevate the flavor of your favorite meats or dishes. Consider a few of these for your next meal prep:

- **Cherry or blackberry:** make an excellent flavor for BBQ sauces for red meat
- **Chile/Lime seasoning** makes EVERYTHING taste better when done on the grill or added to zucchini or cucumber slices in the dehydrator for chips.

  - 2 teaspoons chili powder
  - 1 teaspoon garlic powder
  - 1 teaspoon onion powder
  - 1 teaspoon salt
  - ¼ teaspoon black pepper
  - 2 tablespoons fresh lime powder
- Pineapple 5 Spice Dry Rub
  - ¼ cup brown sugar (learn how to make your own!)
  - 2 tbsps. pineapple skin powder
  - 2 tbsps. sesame seeds
  - 1 tbsp. ground ginger
  - 1 tbsp. salt
  - 1 tbsp. garlic powder
  - 1 tbsp. caramelized onion soup powder
  - 1 tsp Chinese Five Spice Powder
  - pinch red pepper flakes
  - 1 tsp ground white pepper

Remember that fruit powders don't dissolve the way drink mixes do, so keep that in mind as with drink mixes.

- Tea blends: make your own homemade tea blends with fruit powders for that hint of flavor and sweetness. You can even add it to your regular tea for an extra bit of fruit flavor. Using lemon powder can be a great way to have lemon-flavored tea even if you're out of fresh lemons.
- Smoothies: use fruit powder in the morning smoothies in place of whole fruit if you're not a fan of the textures (seeds, etc.) or for intensifying the flavor.
- Flavored Water: Just like using real fruits, put fruit powder into a tea bag or tea infuser and steep into water for a flavor enhancer.
- Cocktails: Mix with a little sugar and use on the rim of a fruity adult drink. Do it with cocktails, too, to make them feel a little extra special.

Storage

Fruit powders are best kept in airtight containers. Because of the sugar content of fruit powders compared to that of vegetable powders, clumping or caking maybe an issue. Use a desiccant pack to help remove any moisture, and a variety of methods such as arrowroot powder, re-blending, or these other methods to help with the clumping issue. Apple and banana powders are especially susceptible and these tips may help.

If storing in bulk, a mylar bag sealed with an O^2 absorber may be a better option to keep the fruit powder away from moisture, oxygen, and light.

Fruit powders, like ground spices and herbs, don't have as long of a shelf life as their whole counterparts. Six to nine months is the time given by the National Center for Home Food Preservation for powders.

Properly dried, conditioned, and stored fruit powder has a shelf life of up to a year. It might last longer, but a reduction of quality, color, and perhaps even texture (clumping) can be seen over time. It is always best to keep dried fruit whole and grind for a shorter-term use if possible.

CONCLUSION

The growth of the global market of dried fruits and vegetables is supported by healthy diet trend, taking an important part in the snacks segment. Also, the nature of dried fruits and vegetables, being easy to store and substituting less healthy snacks as the preparation of such products does not require preservatives or chemical products, is pushing consumers towards this segment. Finally, fitting within the diet of vegetarians, vegans and plant-based diet is making dried fruits and vegetables a main part of multiple niche consumers' diets.

As for the local market, producers have the chance to increase their production and substitute more expensive imported products. Also, producers and farmers have the chance to reduce losses incurred in selling agricultural products and fresh produce by drying these foods, expanding their shelf life, which makes it easier to export and grants them time to find markets for their products. Local producers can benefit from the global trend to supply markets abroad especially tree nuts, increasing their foreign currency revenues and ensuring sustainability amid the current economic and financial crisis in Lebanon.

The Middle East was the top consuming region of dried fruit, with a share of 29% of the total, followed by Europe (24%), Asia (20%), North America (15%), Africa (6%), Latin America (4%) and Oceania (2%). In parallel, Europe was the main consuming region of tree nuts with a share of 30% of the total, followed by Asia (25%), North America (24%), the Middle East (13%), Africa and Latin America (3% each) and Oceania (2%).[14] It is worth mentioning that the U.S., Germany, China, the Netherlands, the UK, France, Russia and Canada were among the largest importers of edible fruits and nuts in 2020. In parallel, Japan, Germany, the U.S., Hong Kong, the Netherlands, Thailand, Canada, France and the UK were among the largest importers of dried vegetables in the same year. As such, there are large opportunities for Lebanese products in the GCC countries and in neighboring countries, including Egypt, Syria and Turkey, as well as in the U.S., Canada and Germany, where many consumers are increasingly turning to healthier diets, and benefiting from the large Lebanese diaspora and from the already existing distribution channels for Lebanese dried fruits and vegetables in these countries.

On the technical side, drying fruits and vegetables is proving to be a way for the farmers to benefit from what they usually consider as wasted inputs, since this technique allows them to sell the lowest grade inputs, where new technologies and machinery are emerging that allow processors to transform what is considered agricultural waste into high demanded consumable healthy products. On the other-hand processors are exploring new products that are highly demanded in the markets with a low cost of production, using new technologies which will prove key to enabling exports to different distant countries. Thus, the dried fruits and vegetables are becoming the new favorites for farmers, processors and consumers alike.

[14]Nut & Dried Fruits Statistical Yearbook 2020/2021, INC International Nut&DriedFruit

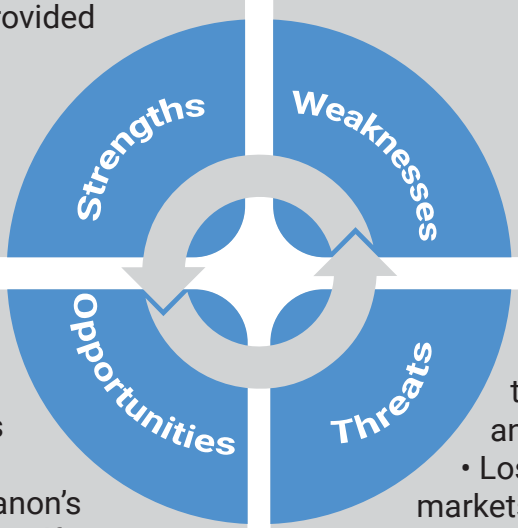
SWOT ANALYSIS

Strengths

- Lebanon's climate diversity which lead to producing variety of dried vegetables and fruits
- Dried Vegetables and Fruits is a part of Lebanon's heritage and traditions
- High Nation branding in Lebanese foods and beverages
- Availability of wide range of options to meet different preferences for making Dried Vegetables and Fruits
- Do not require large investments
- New innovations easily provided

Weaknesses

- Some dried vegetables and fruits are imported from other countries which increase the cost of production
- Some producers are unable to commercialize their output, due to their small size and weak organization
- Technical and quality requirements for production are not easily accessed by small producers due to lack of financing and expertize



Opportunities

- Increasing local market share by Substituting imported dried Vegetables and fruits
- Potential to increase Lebanon's exports especially to Arab Gulf Countries
- Benefitting from the growth in the global demand for dried vegetables and fruits due to health benefits
- Advantage of the current price competitiveness (decrease of LBP exchange rate to dollar) compared to other producing countries which in turn will increase Lebanon's exports
- Increase shelf life of agricultural products for for farmers who are having difficulties in exporting fresh produce

Threats

- Increase in the production costs due to financial and monetary crisis
- Lose access to international markets due to noncompliance with international regulations, standards and technical requirements or due to other obstacles as economic sanctions
- Lose market share against competitors in the Mediterranean due to the repercussions of normalization on the regional level
- Current financial and monetary crisis that could push away investments and deteriorate innovation and quality

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