PROTOCOL OF PRICKLY PEAR HARVEST AND POST-HARVEST HANDLING

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PREFACE

This protocol is prepared by the local and international experts of the project JOSME "*Enhancement of Jordanian SMEs inclusiveness, competitivity and sustainable innovation*" implemented by CIHEAM Bari in Jordan and funded by the Italian Cooperation. This information is provided for the guidance of the food chain SMEs as producers (individual and/or gathered in associations and cooperatives), packagers, traders exporters and any others that deal with this fruit.

The overall expected outcome for this protocol is managing the quality and safety of food and enhancing product added value in the domestic and international markets.

Common name	**Scientific name**	**Family name**	**Variety**
Prickly Pear	*Opuntia ficus-indica* (L.) Mill.	*Cactaceae*	*Local*

1. INTRODUCTION

Cactus pear, *Opuntia ficus-indica* (L.) Mill., (*OFI*) commonly called prickly pear or cactus pear, is the most important economic species of the *Cactacea*e family, because of its large, colored and sweet fruits.

OFI It is native in the highlands of Central Mexico, where winters are dry and cold and summers are hot and rainy. These conditions are just the opposite than in Mediterranean areas, where the winter are mild and rainy and the summer hot and dry. Prickly pear cultivars show a different colour of the flesh, which can be red, purple, orange, yellow and green.

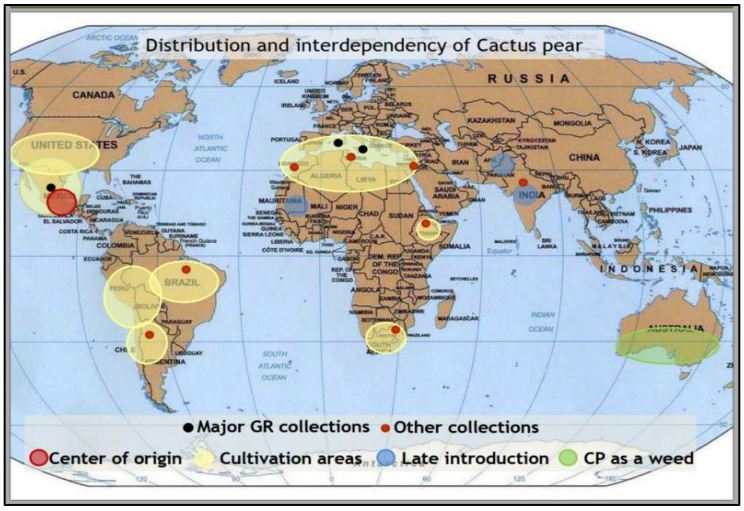

Figure 1. Distribution of main areas for prickly pear cultivation.

The plantation of prickly pear in Jordan started 60 years ago, by importing the cladodes from nearby countries. During that period, prickly pear was planted as hedges around homes and the main roads and in fruit tree orchards. During the last 20 years it was planted under extensive cropping system in the semi-arid areas in the middle of Jordan.

Figure 2. Local prickly Pears

The prickly pear is not included in official statistics of Jordan, as it is mostly harvested from wild plants, and only recently rational plantings have been established, with defined planting distances and roughly agronomic methods. The prickly pear area, according to unofficial but reliable sources, is now estimated at about 664 Ha including cultivated extensive production systems, hedges and mixed plantations. The extensive production systems are located mainly in Madaba, Balqa and Irbid, where farmers grow prickly pears for fruit production.

Prickly pear is also planted in mixed plantation systems, intercropped with other fruit trees, such as fig and olive.

The so named 'local' variety in Jordan is a yellow spineless cultivar (named Baladi). It is grown for fruit production purposes, while there is no major interest for cultivating prickly pear for fodder purposes.

Figure 3. local farmer with prickly pear

1.1 NUTRITIONAL FACTS, HEALTH AND IMPORTANCE

Prickly pear fruit is a fruit oval or elongated in shape, typically weighing 100-200 g, having a thick fleshy skin or rind which consist 60-35% of the total fruit weight. The skin encloses a juicy pulp which consists 40-65 % of the total fruit weight. The pulp has 10 % hard-coated seeds, in fresh weight. Fruit flesh consists of 80% water and 10-15% carbohydrates with a relevant amount (25-40 mg/100 gm) of vitamin C. Prickly pear fruit value is influenced mainly by size, flesh percentage, color, total soluble solids, and seed content. Differences among cultivars include: fruit weight, peel thickness, flesh colour, seed number and chemical composition.

A comparison of the composition of the pulp of cactus pears, orange and papaya fruits.

Component	Cactus pear	Orange	Papaya
Water (%)	85.0	87.8	88.7
Total Carbohydrates (%)	11.0	11.0	10.0
Crude Fibre (%)	1.8	0.5	0.8
Lipid (%)	0.1	0.1	0.1
Protein (%)	0.5	0.4	0.6
Ash (%)	1.6	0.4	0.6
Calcium (mg 100 g^{-1})	60	40	20
Vitamin C (mg 100 g^{-1})	30	50	50
Vitamin A (IU)	50	200	1 100

Source: M. Hernández *et al.*, 1980. Valor Nutritivo de los Alimentos Mexicanos, Instituto Nacional de Nutrición, México, D.F.; USDA Agricultural Handbook 8-9. 1982. Composition of Foods. Fruits and Fruit Juices.

Table 1. A comparison of the Composition of the pulp of prickly pear, Orange and Papaya.

Chemical composition of the pulp and seeds of the fruits of *O. ficus-indica*.

Component	Fruit pulp (fresh wt. basis)	Seed (dry wt. basis)
Water (%)	85.60	5.3
Protein (N x 6.25) (%)	0.21	16.6
Lipid (%)	0.12	17.2
Fibre (%)	0.02	49.6
Pectin (%)	0.19	-
Vitamin C (mg 100 g^{-1})	22	-
B-carotene (IU)	traces	-
Ash (%)	0.44	3.0
Ca (mg 100 g^{-1})	28	16
Mg (mg 100 g^{-1})	28	75
K (mg 100 g^{-1})	161	163
Na (mg 100 g^{-1})	0.8	68
P (mg 100 g^{-1})	15.4	152
Fe (mg 100 g^{-1})	1.5	9

Source: Sawaya *et al.*, 1983 (modified).

Table 2. Chemical Composition of the pulp and seed of prickly pear.

Parameter	Green fruit	Purple fruit	Orange fruit
Moisture	83.8	85.98	85.1
Protein	0.82	0.38	0.82
Fat	0.09	0.02	-
Fibre	0.23	0.05	-
Ash	0.44	0.32	0.26
Total sugars	14.06	13.25	14.8
Vitamin C (mg [100 g]$^{-1}$)	20.33	20	24.1
b-carotene (mg [100 g]$^{-1}$)	0.53	-	2.28
Betanin (mg [100 g]$^{-1}$)	-	100	-

Source: Sáenz and Sepúlveda (2001); Sáenz, Sepúlveda and Moreno(1995); Sepúlveda and Sáenz (1990).

Table 3. comparison of nutritional value for Green, Purple, and Orange prickly pears

1.2 PRODUCT TYPES AND ADDED VALUE

Opportunities for production are:

- ✓ Food and beverage industry (e.g., various food products drinks made from fruit and young cladodes [nopalitos]);
- ✓ Pharmaceutical industry (e.g., gastric mucosal protectors from mucilage extracts, tablets and capsules of cladode powder and flower extracts);
- ✓ Cosmetic industry (e.g., creams, shampoos and lotions from cladodes);
- ✓ Food supplements industry (e.g., fiber and flours from cladodes);
- ✓ Natural additives industry (e.g., gums from cladodes and colorants from fruit);
- ✓ Construction industry (e.g., binding compounds from mucilage/cladodes);
- ✓ Energy sector (e.g., biogas from digestion of cladodes and factory waste streams; alternatively, lignified cladodes burned as fuel wood);
- ✓ Agricultural inputs (e.g., soils, organic materials and improved drainage from the use of prickly pear plant products);
- ✓ Tourism sector (e.g., artisan crafts made from lignified cladodes)

2. HARVESTING AND HARVEST MATURITY INDICES

Prickly pear blooms once a year in **Jordan**. Timing for harvest is crucial in terms of crop value. In **Jordan,** blooming time goes from March to May and the harvesting season ranges from early July to late of September.

Worldwide, Prickly pear harvest season varies depending on cultivar, production area, and orchard management.

Harvesting period and number of pickings changes according to phenology and market demand. For commercial handling, the stage of maturity at harvest is very important for fruit quality. Fruit maturity indices include **peel color breakage**, **fruit size** and **firmness**, being the first the main one used at commercial level. Total soluble solids content at harvest must be higher than 12º Brix. It is suggested to harvest prickly pear at **30-40% color break,** to have optimum quality.

It is suggested to begin harvesting at the lowest possible air temperature, such as early in the morning. This helps avoid the release of glochids, and the fruits remain at low temperatures, which reduces dehydration and infestation.

Stages of development and ripening for prickly pear fruit can be briefly described as follows:

1) Mature green fruits: almost fully developed, with a light green peel.

2) Ripening fruits: peel begins to show color change; color development may vary from incipient up to 35% of the fruit surface; fruits at this stage are considered optimal for commercial harvest.
3) Ripe fruits: have 75-100% yellow/orange peel colour, barely stand post-harvest operations
4) Over-ripe fruits: 100% of peel colour and very low (< 3 kg cm^{-2}) flesh firmness.

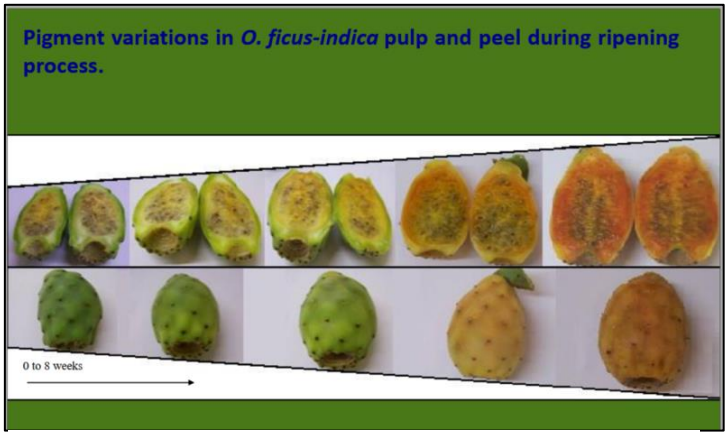

Figure 4. maturity stages of prickly pears

Figure 5. ripped prickly pear fruits

These external changes should correlate with internal quality attributes, but their relative importance varies among cultivars. Others important fruit quality characteristics include:

- ✓ The percentage of the pulp;
- ✓ The resistance of the peel to physical handling.

2.1 QUALITY INDICES

Quality indices include:

- ✓ Total soluble solids - TSS (ranging from 12 to 17 °Brix, depending on cultivar and harvest season);
- ✓ pH (6-6.5);
- ✓ Fruit size (120 -240 g);
- ✓ Flesh percent to total fruit weight (50-60%);
- ✓ Number of seeds in flesh (the fewer the better);
- ✓ Firmness (8-10 kg/cm^2);
- ✓ Fruit shape (from rounded to cylindrical);
- ✓ Cleanliness – no glochids;
- ✓ No apparent defects, insects and decay-causing pathogens;

2.2 MODALITIES OF PICKING

Prickly pear is semi-fragile and extremely perishable fruit that call for careful and appropriate handling during harvesting and transportation to reduce damage and preserve quality. Fruits should reach the consumer in a firm condition. Prickly pear fruits are attached to the mother cladode at an articulation that DOES NOT ALLOW them to be twisted off, without a great DAMAGE. It is, then, mandatory to avoid any twisting of the fruit that have to be harvested using a sharp knife to cut them with a small piece of its mother cladode (in form of a partridge eye) at the base.

Another characteristic of the fruits that leads to postharvest mechanical damage is the presence of glochids. **Glochids** are small barbed spines, consisting of almost pure crystalline cellulose; the number of glochids' tufts varies greatly among cultivars. Fruits with many glochids are more difficult to harvest; the harvester tends to avoid the spiny tufts by using two fingers to grasp the fruit, instead of distributing the force more uniformly across all fingers of the hand. Damage to the peel from finger pressure may be visible at the time of harvest; however, it usually shows up later, during the postharvest period, as discolored areas which often dry out, resulting in an unsightly appearance. Handling for the national market in **Jordan** involves cleaning the fruit manually, sizing and classifying by color, and packing the fruits into polyester crates of approximately 2-3 kg. Most of these operations are usually made in the field with no specific equipment or trained workers being included. The glochids are usually eliminated by spreading the fruits on grass or straw-covered areas or on open mesh tables and brushing with brooms. This result in a great damage of the wax layer which covers the peel. Mechanical removal of glochids after harvest is mandatory to get safe fruit with a proper shelf life.

2.3 DESCRIPTION OF PACKAGES

The crates shall meet the quality, hygiene, ventilation, and resistance characteristics to ensure suitable handling, shipping, and preserving of the prickly pear fruits. Packages must be free of all foreign substances and smells. The most convenient are the paper made ones with plastic alveola specifically shaped for prickly pears which should not be in contact each other.

2.4 PRICKLY PEAR FRUITS POST-HARVEST

Prickly pears are non-climacteric fruit, but a pre-harvest climacteric-like rise was observed at various stage of development. According to metabolic activity post-harvest life can be very short at ambient temperature and 4-6 weeks at 6/8 °C. Prickly pear fruit are very sensitive to **chilling injury** (CI) at temperatures below 6 °C., particularly when temperature during fruit ripening and harvest are > 30 °C. CI causes imbalance in metabolic pathways; loss of firmness, higher rates of degradation of organic compounds and alternations of flavor and taste (acetaldehyde and ethanol).

3. HARVEST AND POST-HARVEST PROCEDURE

3.1 HYGIENE RULES AT HARVEST POINTS

Workers must adhere to good hygiene practices when processing the crop, and receive training in personal hygiene and safety practices. General recommendations include:

- ✓ All workers must maintain personal cleanliness, make sure all of your employees know when and how to wash their hands;
- ✓ Workers must notify their supervisor if they are sick, ant not direct contact with fresh prickly pear fruits;
- ✓ Workers must not eat, chew gum, or use tobacco products at harvest time;
- ✓ Workers must remove or cover hand jewelry that cannot be sanitized;
- ✓ In case of field packing and transport, the producer must carefully check that the operations are properly conducted to ensure that the produce arrives at the packinghouse or at the market in good and clean conditions;
- ✓ In field packing, ensure that selection and grading practices are meeting fresh food hygiene rules;
- ✓ At harvest, appropriate measures should be taken to reduce or eliminate the potential risk of pathogen contamination through soil contact at the cut surface. The reduction or elimination of pathogens can be achieved by cleaning the cutters and collective bins (crates), by increasing the cutting quality, e.g., cutter sharpening, and by guaranteeing the hygiene of the field workers;
- ✓ It is important to know how to clean and sanitize tools, equipment, and surfaces effectively. While cleaning and sanitizing should be focused on food contact surfaces – any surface that comes into physical contact with produce – you should also clean and sanitize “secondary” surfaces that may indirectly contact food or food contact surfaces;
- ✓ Harvesting early in the morning, before plants become warm and their respiration rate increases, reduces the need for cooling and often lengthens the preprocessing storage;
- ✓ Placing the harvested produce quickly under shade, in opaque or dark boxes.

3.2 WORKER SAFETY AT HARVEST

- ✓ Workers must wear protective means such as heavy and long gloves, eyeglasses to avoid contact with glochids, safety shoes and protective clothes during harvest time;
- ✓ Workers must have first aids boxes in well-known places in the farm;
- ✓ Workers must be well trained to use the equipment;
- ✓ Workers must be protected from any dangerous source in the farm: warning signs have to identify the critical area and potential risks;

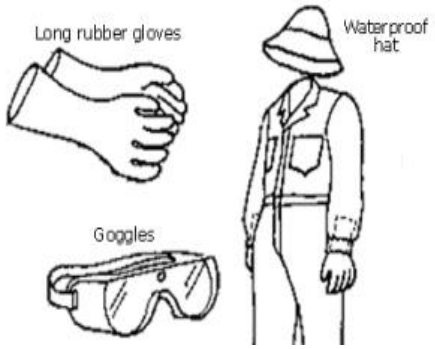

Figure 6. Protective clothing

3.3 TRANSPORTATION OF THE PRODUCT

When crops are harvested at some distance from the packinghouse, the produce must be transported for sorting, packing and storage,

- ✓ The harvested fruits should be transferred to the packing station using large plastic or wooden crates for transport;
- ✓ A first selection in the filed must be performed by specifically trained workers during harvest;
- ✓ The fruit must be transported carefully in the early hours of the morning to avoid heat and refrigeration is recommended in case of long transport time;
- ✓ Speedy transport will also prevent infection by pests which attack the fruit during the post-harvesting period;

Take precautions to minimize the risk of microbial contamination during transit. Pay attention to:

- ✓ Food contact surfaces;
- ✓ Time and temperature abuse;
- ✓ Product integrity, potential or opportunity for unintentional or intentional contamination;
- ✓ Other uses of the vehicle.

3.4 STANDARDS FOR PRICKLY PEAR

There are no commercial standards in **Jordan** for prickly pear, so it is important to rely on the international standards and criteria for grading and sizing prickly pear**.** The international standard (**CODEX STAN. 186**), addresses commercial varieties of prickly pears from *Opuntia ficus indica, O. streptachantha, and O. lindheimeir*i, to be supplied fresh to the consumer, after preparation and packaging. Prickly pears for industrial processing are excluded.

PROVISIONS CONCERNING QUALITY

In all classes, subject to the special provisions for each class and the tolerances allowed, the prickly pears must be:

- ✓ Whole, clean, practically free of any visible foreign matter;
- ✓ practically free of damage caused by pests;
- ✓ free of abnormal external moisture, excluding condensation following removal from cold storage;
- ✓ free of any foreign smell and/or taste;
- ✓ firm and fresh in appearance;
- ✓ free of damage caused by low temperatures;
- ✓ free of glochids;
- ✓ sufficiently developed and display satisfactory ripeness.

The prickly pears must have a shape, color, taste, and smell characteristic of the cultivar.

The development and condition of the prickly pears must be such as to enable them:

- ✓ to withstand transport and handling;
- ✓ to arrive in satisfactory condition at the place of destination.

3.5 CLASSIFICATION

Prickly pears are classified into three classes defined below:

"Extra" Class

Prickly pears must be of superior quality (> 150 g). They must be characteristic of the variety and/or commercial type. They must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce and presentation in the package. Percent flesh ≥ 55%; TSS ≥ 12%; flesh firmness ≥ 8 kg cm^{-2}

Class I

Prickly pears must be of good quality (120-150 g). They must be characteristic of the variety and/orcommercial type. The following slight defects, however, may be allowed, provided these do not affect thegeneral appearance of the produce, the quality, the keeping quality and presentation in the package:

- ✓ slight defects in shape and color;
- ✓ slight skin defects such as bruising, sunspots, crusting, blemishes, or other superficial defects. The total area affected shall not exceed 4%;

- ✓ The defects must not, in any case, affect the pulp of the fruit.
- ✓ Percent flesh ≥ 50%; TSS ≥ 12%; flesh firmness ≥ 8 kg cm^{-2}

Class II

This class includes prickly pears which satisfy the minimum requirements (100-120 g). They must be characteristic of the variety and/orcommercial type. The following defects, however, may be allowed, provided the prickly pears retain their essential characteristics as regards the quality, the keeping quality and presentation:

- ✓ defects in shape and colour as long as the product has the characteristics common to prickly pears;
- ✓ skin defects due to bruising, scarring, crusting sunspots, or other defects. The total area affected shall not exceed 8%;
- ✓ The defects must not, in any case, affect the pulp of the fruit.
- ✓ Percent flesh ≥ 50%; TSS ≥ 12%; flesh firmness ≥ 8 kg cm^{-2}

PROVISIONS CONCERNING TOLERANCES

Tolerances in respect of quality and size shall be allowed in each package for produce not satisfyingthe requirements of the class indicated.

"Extra" Class

Five percent by number or weight of prickly pears not satisfying the requirements of the class, but meeting those of Class I or, exceptionally, coming within the tolerances of that class. No glochids.

Class I

Ten percent by number or weight of prickly pears not satisfying the requirements of the class, butmeeting those of Class II or, exceptionally, coming within the tolerances of that class. No glochids.

Class II

Ten percent by number or weight of prickly pears satisfying neither the requirements of the class northe minimum requirements, with the exception of produce affected by rotting, pronounced irregularities or any other deterioration rendering it unfit for consumption. No glochids.

Size Tolerances

For "Extra" Class, 5%; and for Class I or Class II, 10%; by number or weight of prickly pears not satisfying the requirements as regards sizing, but falling within the class immediately above or below or those indicated above in sizing.

PROVISIONS CONCERNING PRESENTATION

The contents of each package (or lot for produce presented in bulk) must be uniform and contain only prickly pears of the same origin, variety, quality, and size. For the "Extra" Class, color and ripeness should be uniform. The visible part of the contents of the package (or lot for produce presented in bulk) must be representative of the entire contents.

3.6 PACKAGING

Prickly pears must be packed in such a way as to protect the produce properly. The materials used inside the package must be new, clean, and of a quality such as to avoid causing any external or internal damage to the produce. Prickly pears shall be packed and labeled in each container in compliance with the recommended rules of the final destination market.

3.7 SAFETY AND HYGIENE STANDARDS AND REQUIREMENTS FOR PACKAGING

Fruits should preferably be packed in corrugated fiberboard cartons of sizes ranging from 12-15 (1.5-2.0 kg) fruit or in plastic baskets of different sizes.

- ✓ Packaging is done in clean, sound, and appropriate packages that protect the integrity of the fruit, preserve it from pollution, damage, and dryness and preserve its natural properties - so that the packaging materials used comply with the requirements contained in the Jordanian technical rules;
- ✓ The packing materials used inside the package shall be new, clean, and of a quality that does not cause any internal or external damage to the prickly pear;
- ✓ When using seals or adhesive papers, they must meet permissible commercial specifications, provided that the printing or adhesive papers are made of no-toxic ink or glue;
- ✓ The containers shall be free from foreign substances;
- ✓ The visible portion of each package is representative of its entire contents;
- ✓ Transport and handling shall be in a suitable manner that protects it from rain, sun, or any other sources of excessive heat, unwanted odors, and any other sources of pollution, especially when transported by sea freight;
- ✓ Storage rooms shall be dry and free from undesirable odors and protected from the entry of insects and rodents, and ventilation shall be organized in a way that ensures that it is

good in dry periods and can be stopped permanently in periods of excessive humidity and heat;

- ✓ Disposable packages should not be re-used.

3.8 LABELING

Each package shall be labeled as to the name of the produce and may be labeled as to the name of the variety, class, size (if sized) and/or weight.

The sales units could be identified with a label with the following information:

- ✓ Net weight;
- ✓ Country of origin;
- ✓ Address of the packer of the product ();
- ✓ Product, variety and Category (class or grade);
- ✓ Company brand, if available;
- ✓ Lot of produce (alpha numeric code or barcode/QRcode and/or others) for traceability;
- ✓ Storage conditions;
- ✓ Quality assurance and certificates if available or required;

3.9 PACKING-HOUSE SAFETY AND HYGIENE REQUIREMENTS

Main rules to be guaranteed for produce sorting, packing and storing:

- ✓ The packinghouse layout should be designed in such a way as to keep the raw material and the finished product separate and to encourage the smooth flow of the product through the selection and packing system;
- ✓ The fabric of the building must be in good condition. Windows when open, must be screened to prevent insect ingress;
- ✓ Air flow should guarantee safe and hygienic conditions during all the stage of the activities;
- ✓ Light level must be adequate for selection and grading;
- ✓ Separate, defined area used only for packing should be identified. Storage of cartons must not be carried out in the packing area;
- ✓ There should be adequate facilities for the collection and disposal of waste material at frequent intervals to discourage fly infestation and the development of latent fungal infection;
- ✓ Risk of contamination from local industries should be minimized;
- ✓ Fly/insect catchers should be installed in the packinghouse and a no smoking policy should be implemented in the area where prickly pears are packed;

- ✓ Protective clothing that adequately covers day-to-day clothes must be worn in the packinghouse at all times;
- ✓ Smoking, chewing tobacco, and spitting should be strictly forbidden in the packinghouse;
- ✓ Rest areas, away from production should be provided for food and drink consumption;
- ✓ The storage of chemicals, disinfectants, cleaning agents, fuel and oil should be in a secure area, kept away from the packinghouse.

4. POST-HARVEST PHYSIOLOGY AND DECAY PROBLEMS

4.1 CHILL INJURY

The sharp increases of fruit weight loss when fruit are removed from chilling to non-chilling temperature were related to occurrences of microscopic cracks of the rind. Susceptibility to CI is related to genetic background and environment.

Figure 7. Chilling injury symptoms

Disease control strategies include good orchard sanitation, effective pre-harvest management to reduce infection, careful handling to reduce physical damage, prompt cooling to 10°C and subsequent maintenance of that temperature throughout the handling system.

Figure 8. Fungal infestation

4.2 INSECT CONTROL

Mediterranean fruit fly (Medfly). Prickly pears are preferred host for Med fly and must be treated for disinfestation to be accepted in many countries. Fruit may contain eggs or larvae of various developing stages, depending upon the elapsed time between fly oviposition and fruit harvest.

At normal refrigeration temperature (5-8 °C), larvae continue to grow, and at the end of storage fruit can show visual damages. Flies from infected fruit can develop during storage.

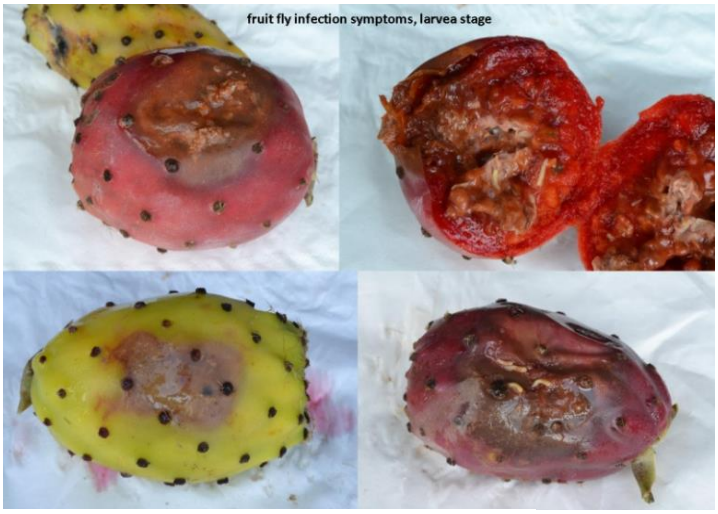

Figure 9. Med fly infestation on ripe prickly pear fruit

The following picture shows different symptoms of infected prickly pear with Med fly.

4.3 OPTIMAL STORAGE TEMPERATURE

- ✓ Postharvest life can be very short at ambient temperature.
- ✓ Optimal storage temperatures (6-8 °C) result a storage potential of 4-6 weeks, depending on cultivar, ripeness, stage and pre-harvest environmental conditions;
- ✓ Optimum Relative humidity 90-95%.

5. REQUIREMENTS FOR THE INTERNATIONAL MARKET

Before entering into a business relationship with a partner from a foreign country, it is necessary to know the specific legislation applied by that country for that particular product. Regulations on food hygiene and pesticide residue limits (and eventually microbial contaminants) in foodstuffs, labelling and commercial presentation regulations and all notifications and controls (including phytosanitary controls) required for entry into the foreign country must be considered. So, the main elements of a business relationship are based on:

- ✓ share the same "language" between trading partners for of all the applicable rules (mandatory and voluntary);
- ✓ Guarantee the origin of product;
- ✓ Guarantee food safety;
- ✓ Put on the market products with stable and recognizable quality

As pre-requirements a certificate of product is preferable and it depends on the importing country and specific request of the direct client.

The main European trade players ask for BRC (British Retail Consortium) for United Kingdom market as IFS (International Food Standard) certificate to the packers. Both these standards guarantee against food hygiene management, food traceability and quality management. On primary production side, a GlobalGAP certification is generally requested by traders from several countries. This Protocol is able to guarantee the correct application of Good Agriculture Practices, the control of the environmental impact of the agriculture activities, the workers health and safety management on farm and the respect of the rules on usage of pesticides and the continuous monitoring of pesticides residue. A voluntary certificate on the application of the HACCP principles on the firm could be an asset.

About the Maximum Residue Limits, the official database of the destination country should be consulted.

In particular for the European countries:

https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en

For other countries that do not have their own legislation, reference can be made to:

http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/pesticides/en

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