

Small Scale Equipment for Date Processing

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Abstract. *In many countries in North Africa and Middle East dates are processed into various products to prolong preservability and widen possibilities of utilization. Most of them are traditional products that are obtained through house or industrial processing. One process that almost all dates have to go through after harvesting is drying, while fumigation is reserved to those dates that are suspected to have been infested by insects or other pests. After these preliminary treatments dates can be marketed whole or pitted but in many countries of origin it is common to make juice, syrup or paste. In some countries large and modern plants have been set for date processing, but the investments are high and are convenient only where large and intensive plantations are present. In Iraq traditional processing is widespread but there are not many efficient plants.*

Answering to a specific request from the Directorate of Agriculture of Dhi Quar (Iraq) Province, where date palm is an important cultivation, a small scale date processing line was projected, installed and tested with the aim of improving hygiene and quality of the processed products and rationalizing the final part of the chain.

A dryer and a fumigation chamber with the capacity of about 4,000 kg were obtained by simple interventions on a 20' container, while some machines for processing of olives were adapted to date processing. The line with a capacity of about 150 kg/h of fresh dates, consisting of a destoner, a mixing bowl, a decanter, a vacuum packer and a mill for seeds was tested in Iraq by a work team composed by DIAF and Directorate of Agriculture staff. The line was able to destone dates into a smooth thin paste that could be directly packed or used, with addition of water, for producing syrup or fresh juice. The seeds were crushed into powder for animal feed, while vacuum packing was found suitable for preservation of whole, semidried dates, according to local traditions. The line, which cost less than 60,000 euro, was found suitable for local small scale processing although some modifications had to be carried out in order to improve its functioning.

This contribution describes the line from the dryer to the seed mill and the results of the first trials carried out in 2006.

Keywords. Processing, drying, fumigation, syrup, paste, destoner, small scale equipment.

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Introduction

Dates (fruits of *Phoenix dactylifera*) are an important agricultural product in Iraqi Province of Dhi Qar and more than 400,000 palms are cultivated, mainly in groves close to the rivers and channels. Iraq was once a leading Country in date production and exportation and processing was common in many specialized industries, while nowadays date palm cultivation and processing is generally carried out with low input traditional methods. Dates are collected at different ripening stages (*khalal*, *rutab* and *tamr*) depending on the destination and, even if processed, mostly destined to the local market. Most common conservation method is sun drying *rutab* or *tamr* semi-dry dates and pressing them into baskets to obtain a compact tight mass recovering the juice (honey) that percolates during the process. The date block is then stored in the same baskets or plastic bags and sliced or broken up when dates are needed. Pressed dried dates are eaten, generally after loosening the block to separate the single fruits, or used for cooking or for pastry; date juice is sometimes heated to concentrate it and used for pastry or as a spread. Another way of making syrup is to boil dates of lower quality in water and press them to obtain a juice that is then filtered and concentrated. These methods of processing are widespread in the province at household level and also applied by a few local small, low technology industries. More complex processing, such as pitting and stuffing of whole dates are normally done manually.

In fact modern and productive equipment and large processing plants are viable only where intensive and rational plantations are established and where the possibility of exporting to richer markets makes processing convenient. In any case the need to improve and modernize local date industry is perceived by Local Authorities, since locally produced dates, though of high quality at harvest, are not up to the standard of those of other date producing countries of the region. The sector is too poor anyway to make the introduction of modern automatized large capacity processing lines rentable.

In order to address Dhi Qar Province's specific needs the Italian Foreign Affairs Ministry has funded a project aimed to evaluate the possibility of processing dates, according to local tradition, with the use of small scale modern equipment. The Department of agricultural mechanization on the University of Florence (DIAF) was instructed to evaluate possible solutions.

Identification of a suitable processing line was planned in two phases: testing of new equipment and arrangement of a small scale date processing plant according to the results of the first phase. In this paper the first phase is discussed, while second phase is still in progress.

Date processing

There are many varieties of dates that can be harvested at different ripeness stages. As for other fruits, among these combinations, some are ore best for fresh consumption, others for drying or processing into paste, syrup or other products. Also the quality is important, since most spoiled dates are normally processed, regardless of the variety. According to local needs and tradition and market request dates can be processed into cubes, paste, spread, sugar, jam, jelly, juice, syrup, vinegar or alcohol; sometimes there are very slight differences between processing methods.

Date processing in modern, large scale plants

When necessary drying is done in artificial dryers with heated air circulating across the dates stored in plastic trays or crates. In automatic dryers trays are positioned on trolleys and proceed

along a tunnel from one entrance to the other, through a flow of warm dry air. Dates can be infested by insects that could spoil unprocessed fruits so a treatment for killing insects and their eggs is often necessary. This can be done by exposing for some time dates to high temperatures in dry air or steam or fumigating them with chemical, insecticide vapors; the two last methods must be applied in airtight chambers. Dates are then washed on vibrating tables with pierced bottoms and sorted on tables or conveyor belts. These preliminary operations are normally necessary for all kind of dates.

Whole dates are then packaged in boxes or in bags under vacuum. Normally handling is manual while dosing is done with scales.

Among processed products, paste is obtained by re-hydration of dates (if dry) in a steam tunnel and pulped in a destoner and successively minced to an homogenous agglomerate. The paste is then pumped to an extruder that produces a continuous flow of compact paste which is cut into pieces by a cutter and then packed in trays.

Syrup instead is obtained by a complex procedure based on the diffusion of sugar and other components from crushed dates in water. A crusher processes whole loose or pressed dates and warm water is added in a mixer. The paste is then drained on a sieve and more water is added, in some cases after eliminating the seeds with a separator. The liquid drained from the paste is clarified in a decanter and successively in a vertical centrifuge, solids obtained are fed to the primary mass for further extraction. The clear liquid is finally concentrated under vacuum in a tubular evaporator. The syrup is then cooled down and bottled using an automatic filler.

Modern large plants can handle up to 5 t/day of fresh product, but no such firm is present in Dhi Qar.

Household date processing

At farm or family level tamr dates are sun dried in the groves under the trees and no post-harvest pest control takes place. Semi-dry and dry dates are then sold directly to the market or pressed into baskets and stored. When processing for making syrup takes place, mashed dates are boiled in water and then pressed to squeeze out the juice that is filtered and boiled to evaporate the water.

Objective

Various small-scale date processing equipment is manufactured in date producing regions, but it is often low quality or inadequate to satisfy current international safety or hygienic standards. Italy is an international benchmark for modern food processing technology and all the equipment manufactured meets international standards, thus the study was aimed at evaluating the possibility of adapting existing equipment to date processing taking into account the work parameters and the suitability of the technological level. In particular, olive processing machines are produced in large quantity in Italy at different scale and technology, often by small artisans, and this sector has been studied in depth during the preliminary assessment. The use of EU certified equipment would constitute a first step towards improving safety and hygiene, while specific training on their use would be the complement.

Methodology and equipment

In the first phase the main processing steps considered were:

- Drying
- Fumigation
- Washing
- Stoning/pulping
- Mixing of the paste with water
- Juice separation
- Juice clarifying
- Whole date packaging under vacuum

The aim was to identify simple and affordable solutions that would constitute an improvement of the actual technique, not necessarily the best possible solution to the problem.

Drying

The need to dry large quantities of dates in a protected and easy to clean environment suggested to adapt one of the containers that would be used to ship the equipment. A container is an almost airtight and protects what is inside from dust and insects and can be turned into a dryer by allowing warm dry air to circulate inside it collecting moisture from the product and transporting it outside. The air must be continuously renewed and shouldn't be too hot (over 60°C) for not spoiling the physical and organoleptic characteristics of the dates. Normally the air is heated outside the drying chamber and forced through the product by a fan.

The container was provided of 4 windows in the lower part that were protected by an air filtering fabric and could be closed with aluminum plates, while 4 suction fans were installed in the upper part (figure 1). In order to allow air inside only through the filters, the small air circulating vents of the container were sealed with silicon.



Figure 1: The container being transformed into dryer and fumigating chamber

When running the fans would aspirate the air from inside the container, forcing new air to enter through the windows. Heating the air was considered unnecessary because in Iraq in the harvest period outside air temperature passes 40°C and the relative humidity is always very low. In practice the drying takes place with forced circulation of filtered natural air. The lay-out of the openings was the most suited for assuring continuous fast and complete air replacement considering the container's structure and the need for some protection from rain and wind.

The 20 feet container can hold about 1 ton of semi-dry dates arranged in trays stacked on trolleys.

Fumigation

The same container adapted for drying can be used as a fumigation chamber when the openings are sealed. A container however is never completely airtight so fumigation can only take place after sealing the doors. This can be done after closing, by applying special gluey paper on the door's rims. The windows are closed with metal plates while lids are applied on the fans (Figures 2 and 3). After fumigation is completed lids and plates are removed from outside and fans are activated to ventilate the inside before opening.

This kind of fumigation chamber is fit for fumigation at atmospheric pressure but not under vacuum, so application time is long, around 100 hours.



Figure 2. Sealed fans during fumigation



Figure 3. Opening of the windows after fumigation

Washing

Washing of fruit is normally done by spreading out the fruits on a perforated plane and spraying them with water jets although more thorough cleaning includes removal of various kind of foreign matter.

An small oil olive washer manufactured in Italy (TEM, Tavarnelle VP , Firenze) was used to evaluate the applicability of the principle to date washing. It is constituted by a metal case open on top with a perforated plate where trays are laid while water is pumped in a punched pipe that runs above the box; under the plate the percolating water is collected in a pyramidal funnel and can return to the bar or be discarded.



Figure 4. washing of dried dates

Stoning/pulping

Dates destined to juice or paste production are stoned and pulped at the same time. Also in this case an olive stoner produced by TEM was chosen. The machine is composed by a hopper with an auger that feeds the olives to a large horizontal perforated drum inside which olives are pounded by a rotating beater that forces the pulp across the perforations while the seeds are hurled out of the open end. The paste flowing through the drum falls on a tray on the bottom of which an auger conveys it to a pump.

Mixing

In olive processing for oil extraction, olive paste is stirred for some time before oil separation, this is done in horizontal or vertical axis kneaders with hot water bath system. This machine can be used as a mixer to enhance the diffusion of date sugars from the into the water. The possibility of heating up the paste contributes to the process.

Juice separation and clarifying

The liquid juice can be separated from the solid phase in a decanter centrifuge. This kind of centrifuge is able to separate most of the fiber and other solids from the juice, but is not capable of producing a completely clarified juice. The liquid phase must be successively filtered in a filter press.

Seed grinding

Date seeds, as most other seeds, have good nutritional properties and can be fed to various animals, such as poultry, after grinding into a meal. Olive hammer mills, used to crush olives before oil extraction, can be used for crushing date seeds and various other vegetable material.

Other equipment

Beside these machines a 5 liter vacuum packager and a filler were selected to complete the chain. This equipment is commonly used in food industry and didn't need a particular assessment. A grinder for chopping the date seeds into a coarse flour was also added to the processing line since seeds can be used as animal feed.

Date processing trials

All the equipment was first tested in Italy, using 150 kg of dried Iraqi dates from Dhi Qar Province. After testing some modification was done to the machines and then all the batch was shipped to Iraq for the final testing and training of the local operators.

The trials in Italy showed that the destoner, that was projected for processing fruit with high oil content, was not due to the task of processing dates because of the high friction of the sugary dry paste with the metal moving surfaces: the auger was not able to feed properly the drum since the dates were compressed and didn't detach and fall at the end of the auger, the electric motor driving the beater was not powerful enough and the cylindrical shape of the drum, that was formed by rolling a metal sheet, was too irregular and seeds got caught between the inner surface and the beater's paddles braking. The mixer resulted good for the process but heating needed to be enhanced in order to keep the mass warm. The grinder appeared to be successful in mincing a small amount of seeds.

After changing the stoner's motor with a more powerful one, modifying the auger, grinding the drum and opening larger holes and adding more electric resistances to the mixer, the equipment was transferred in Iraq, in Tallil Air-base, close to Nassiriah, and installed in a prefabricated building specifically arranged in Italy. Further testing was done together with Iraqi technicians that were thus trained "on the job".

About 600 kg of Khadrawy and Austa-Umran variety dates were bought on the local market and dried and then fumigated in the container. The dates were laid into the trays and washed with a hose-pipe and then placed in the container. Since the dates were already semi-dry drying time was very short (about 2 days) while fumigation with Phosphine lasted 4 days as specified by the dealer of the product.



Figure 5. Fumigation inside the container



Figure 6. Date processing prefab

Successively some of the dates were packed under vacuum while the rest was processed into syrup after soaking in warm water.



Figure 7. Layout of the processing line

Results

The tests in Iraq resulted in the production of a sweet milky liquid of about 25 °Brix, very refreshing and palatable, coming out of the decanter. This liquid was filtered but not further concentrated since this final part of the processing is done in vacuum evaporators, commonly used in juice processing, that didn't need to be tested in the first phase. Filtering showed that

the centrifuged liquid still had a high content I fiber and other impurities and that a higher capacity filter would be needed.

The seeds out of the stoner were unbroken and satisfactorily clean but the grinder failed to produce a suitable meal because the auger couldn't manage properly high amounts of sticky seeds.

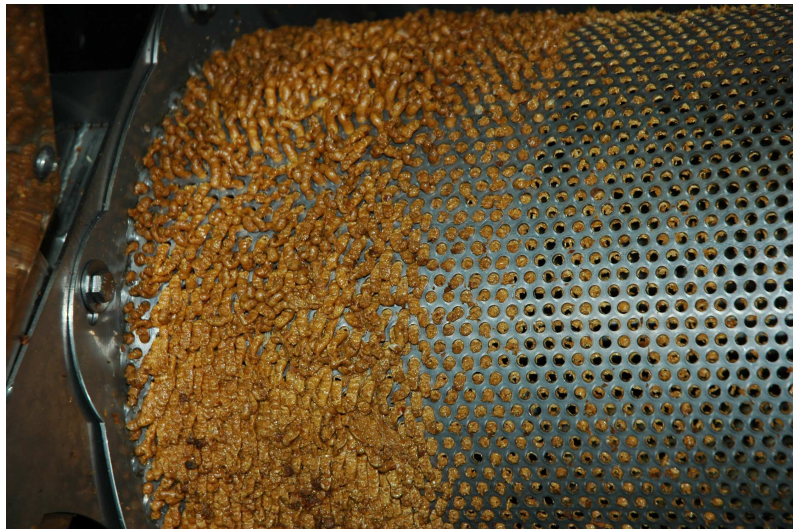


Figure 8. Paste coming out from the stoner



Figure 9. Date seeds expelled by the stoner



Figure 10. Pouring date paste into the mixer



Figure 11. Juice coming out from the decanter

Conclusions

Improving Iraqi date processing industry is possible with the use of adapted equipment such as a container and other small scale machines. The container can be transformed into a dryer or fumigation chamber with simple modification while juice and syrup can be obtained with simple interventions, from an olive processing line. The equipment consist in modern, medium technology level, machines built to meet European standards that can enhance safety, hygiene and quality levels in the food processing sector. Dates must be processed at the semi-dry stage or earlier, otherwise water must be added from the beginning and stoning is difficult and slow, The decanter must be specifically adjusted since olive oil models might not be too effective. The resulting juice is a pleasant beverage and can be filtered and concentrated into a syrup. Whole dates, after washing, drying and fumigation can be packed under vacuum to maintain freshness and quality, while seeds resulting from stoning can be grinded into animal feed, but in this case olive crushers need to be further adjusted.

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