

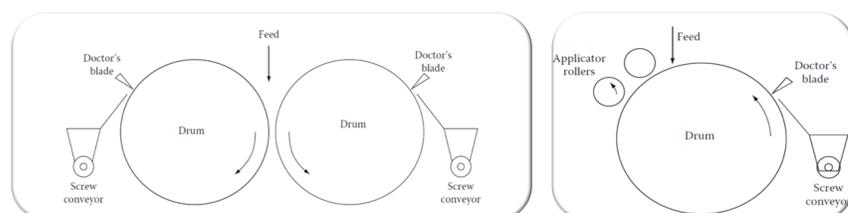
Project Background

- Use of drum drying to remove water content from California specialty crop pomaces and purées.
- Provide heating power needed for drying from innovative solar thermal collectors.
- Identify the feasibility of adapting solar thermal energy for use with existing drum drying technologies.

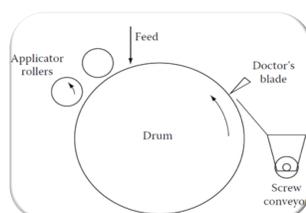
Drum Drying

- Consist of one or more rotating steel cylinders.
- Traditionally powered by steam condensing on the inside surface.
- Highly versatile in the ability to adjust surface temperature, rotation speed, and application thickness.
- Ideal for agricultural and food processing where there is a solid/liquid combined byproduct or waste stream.

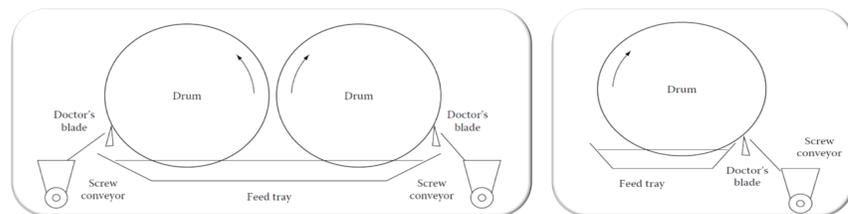
Types of Drum Dryers



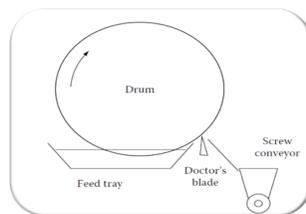
Top Fed Double Drum



Top Fed Single Drum



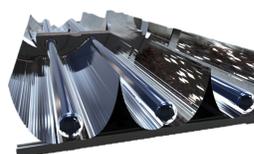
Bottom Fed Double Drum



Bottom Fed Single Drum

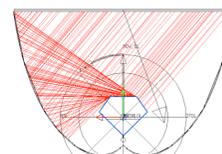
The External Compound Parabolic Concentrator (XCPC)

XCPC Collector



- Evacuated tubes with concentrating reflectors
- Medium temperature range
 - (100°C ≤ T ≤ 300°C)
- High solar to thermal efficiency
- Non-Tracking
- Low cost and low maintenance

Optical Design



- Non-imaging optics reflector design.
- Ideal theoretical concentration ratio.
- Accepts both diffuse and direct light within angular limit.
- Evacuated glass tube reduces heat loss from conduction and convection.
- Mineral oil heat transfer fluid carries heat from absorber.

Solar Integration of a Drum Dryer

- Drum dryer to be operated using mineral oil heat transfer fluid rather than steam.
- Heating power to be provided by an XCPC array connected to a double drum dryer via a heat exchanger.

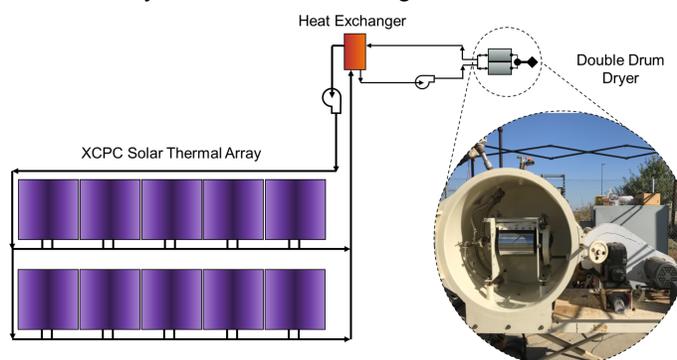


Figure 1 – Illustrative diagram showing integration of a small double drum dryer with an XCPC solar array.

Experimental Procedure

- 48 Prune and 48 Tomato pomace samples were tested in a split plot experiment.
- Four independent variables were tested to determine optimum drying conditions for the solar powered drum dryer.
 - Temperature of the inlet oil to the drum dryer [C]
 - 139°C, 151°C, 164°C
 - Rotation speed of the drum [Hz]
 - 12.57 Hz, 8.22 Hz, and 6.08 Hz
 - Correlates to dwell time of pomace on drum surface [min]
 - 2 min, 3 min, and 4 min respectively
- Maltodextrin added to the pomace as a carrier [% of total]
 - 0% to 20% of total weight
- Pomace to water ratio [1:X]
 - X = 0 to 2 parts water

Drum Drying Heating Power

The system thermal efficiency is defined as the ratio of the thermal power provided to the drum dryer to the solar thermal power provided to the heat exchanger:

$$\eta_{System} = \frac{Q_{Drum\ Dryer}}{Q_{Solar}}$$

Figure 2 shows a plot of the system efficiency vs the inlet drum temperature. It is apparent that system performance of the drum dryer is stable within the operating temperature range of the experiment. Major factors that influence the system performance are the solar collector efficiency, and excess heat loss through plumbing and the heat exchanger. Future work could characterize the integration of an XCPC solar array and a drum dryer to optimize performance.



Figure 2 – System Efficiency of a XCPC solar thermal powered double drum dryer

Pomace Drying Results

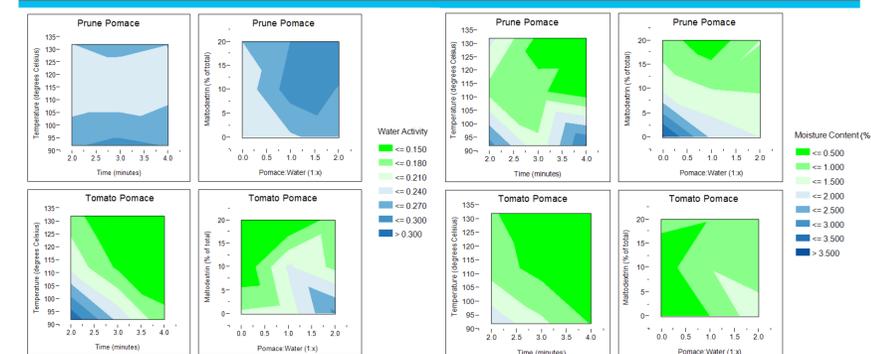


Figure 3 – Water activity results for Prune and Tomato Pomaces. Shelf stability for values less than 0.6

Figure 4 – Moisture content results for Prune and Tomato Pomaces.

Acknowledgements

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