TICA
Thailand International Cooperation Agency

80th Anniversary
SILPAKORN UNIVERSITY

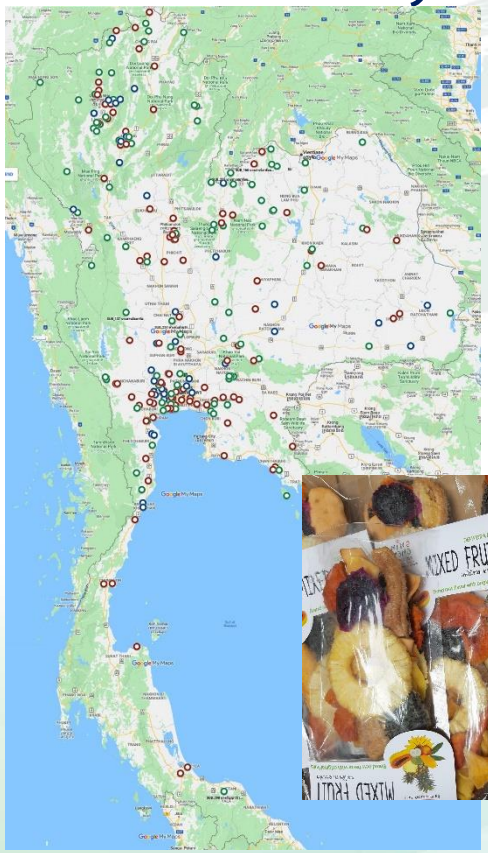
Annual International Training Course (AITC) 2023

The application of a parabolic greenhouse solar dryer together with raw material preparation techniques to extend shelf-life and enhance quality of agricultural products

24 April – 5 May 2023

Lecture 6_26 April 2023

Drying of tropical fruits using a solar dryer



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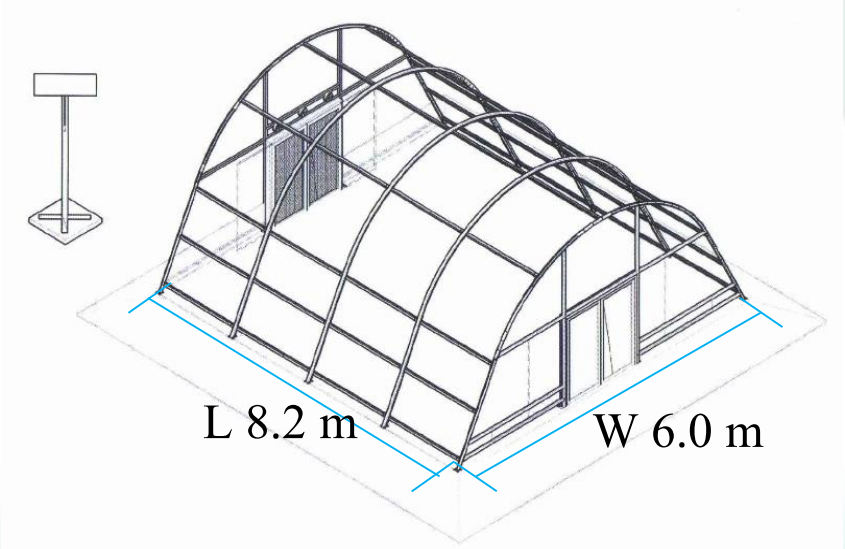
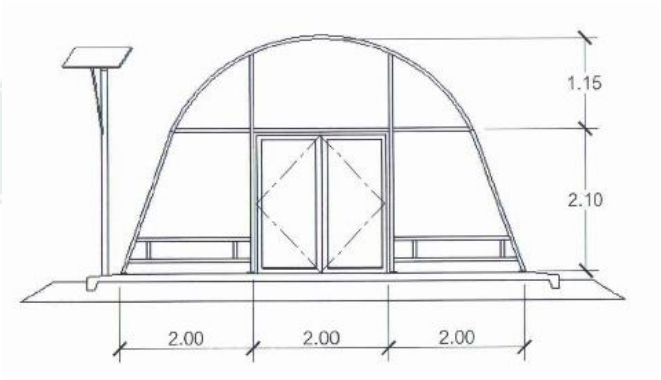
A parabolic greenhouse solar dryer_Thailand

approximate price without the cost of transportation

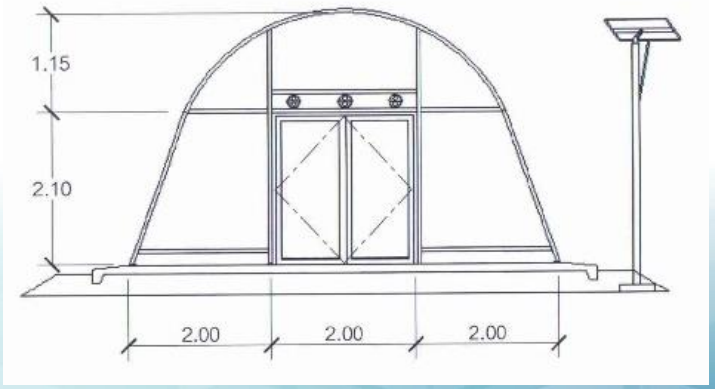
= 10,000 US dollar



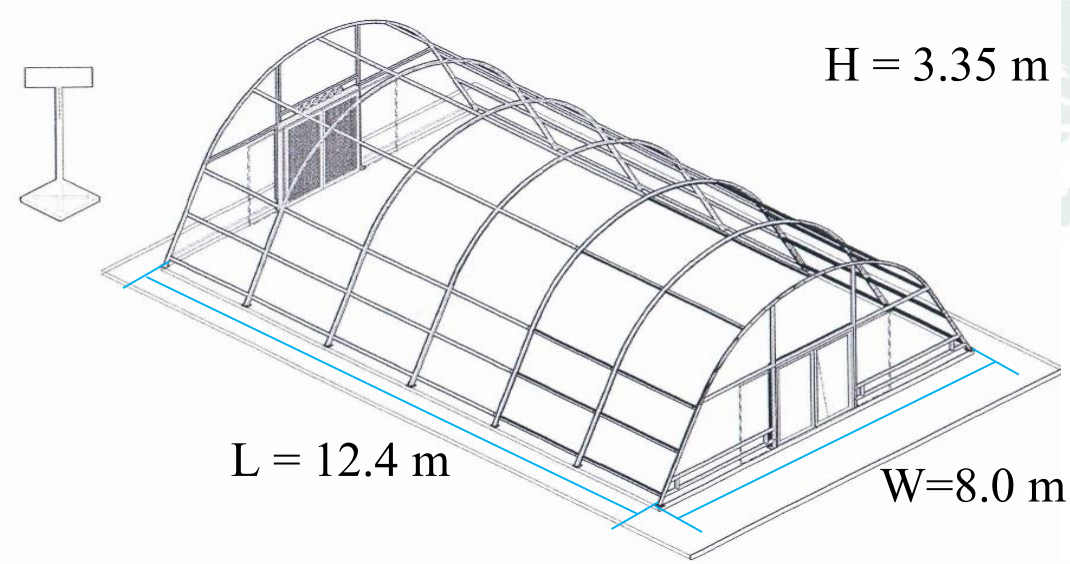
24 trays

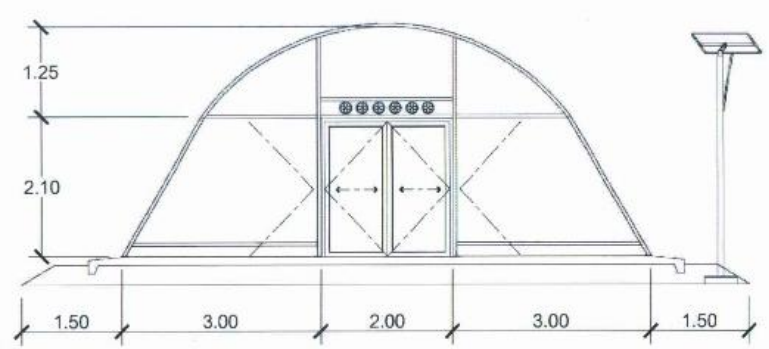


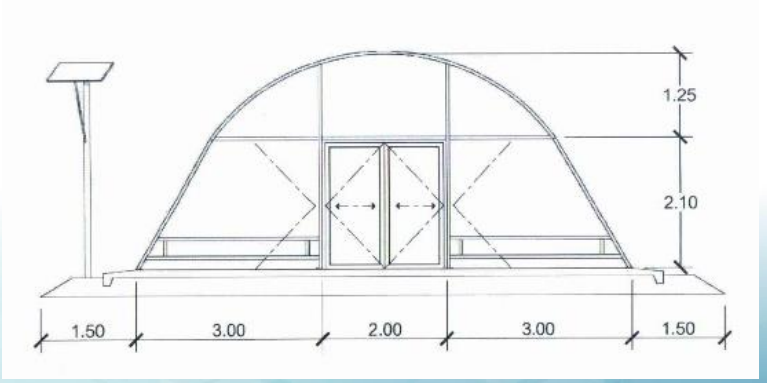
H = 3.25 m



A parabolic solar dryer_Thailand





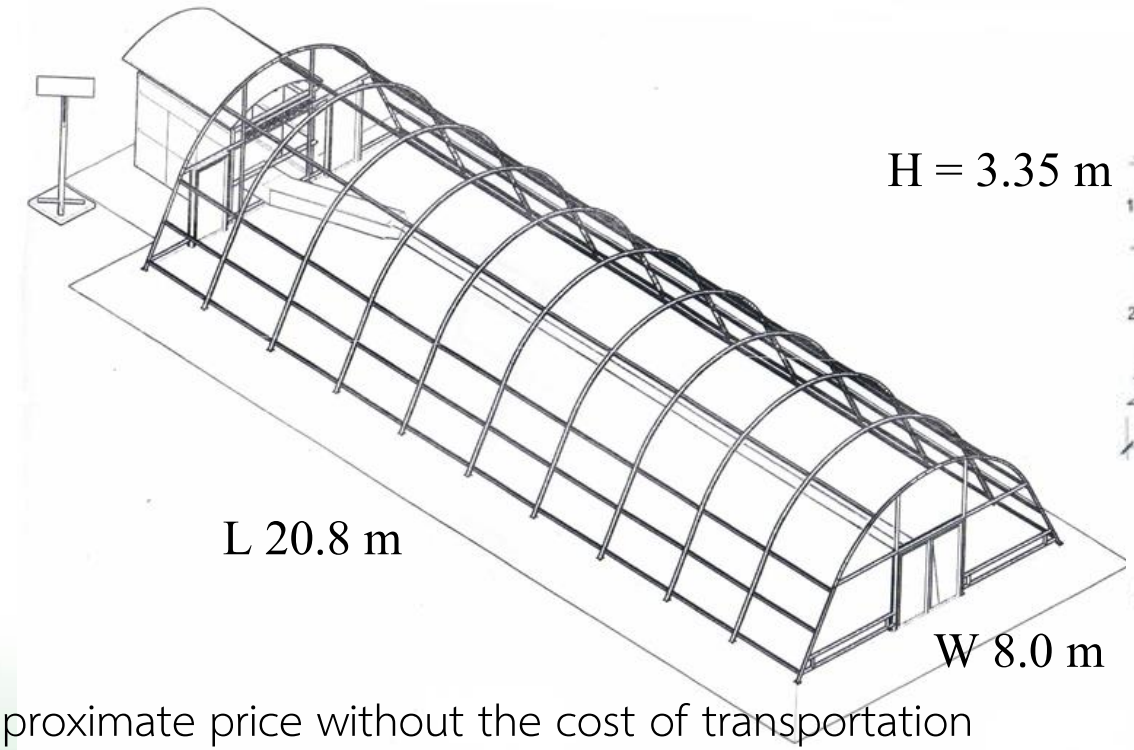


approximate price without the cost of transportation

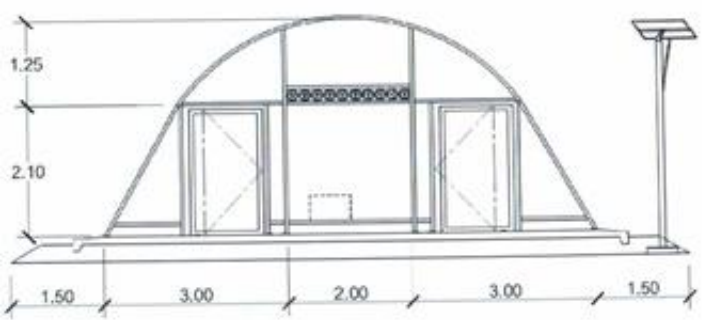
= 19,000 US dollar

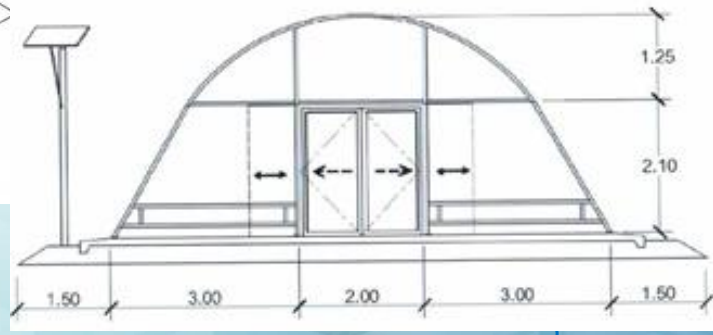
60 trays

A parabolic solar dryer_Thailand



H = 3.35 m





approximate price without the cost of transportation

= 25,000 US dollar

108 trays

A parabolic solar dryer_performance

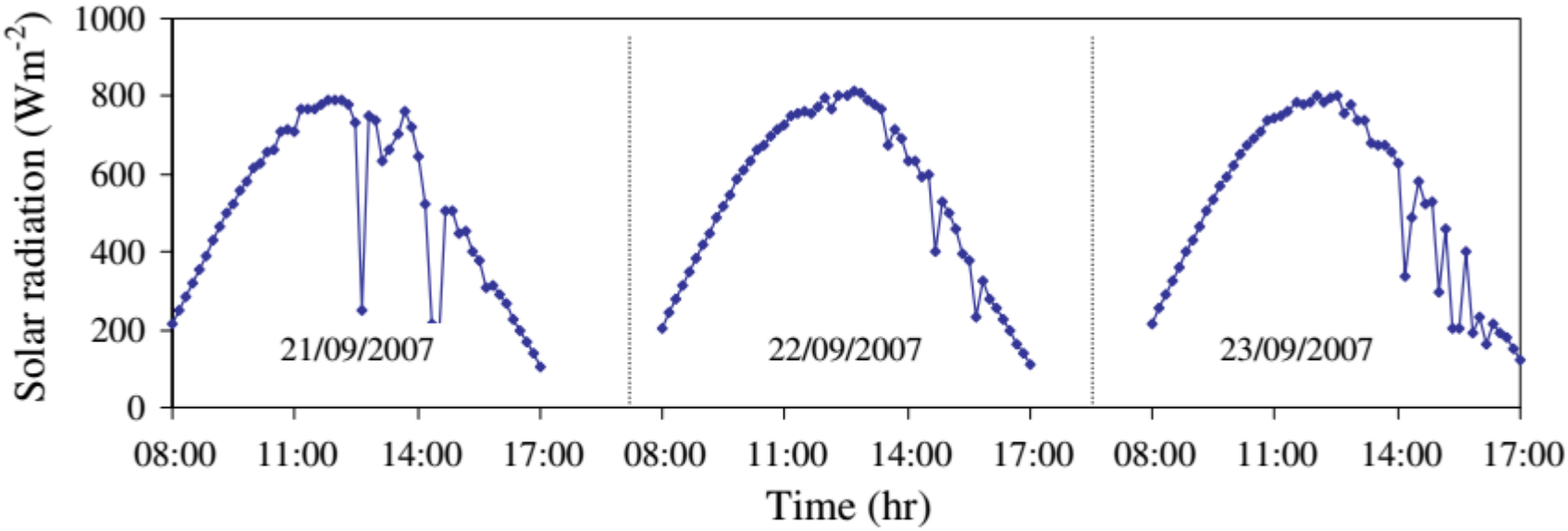
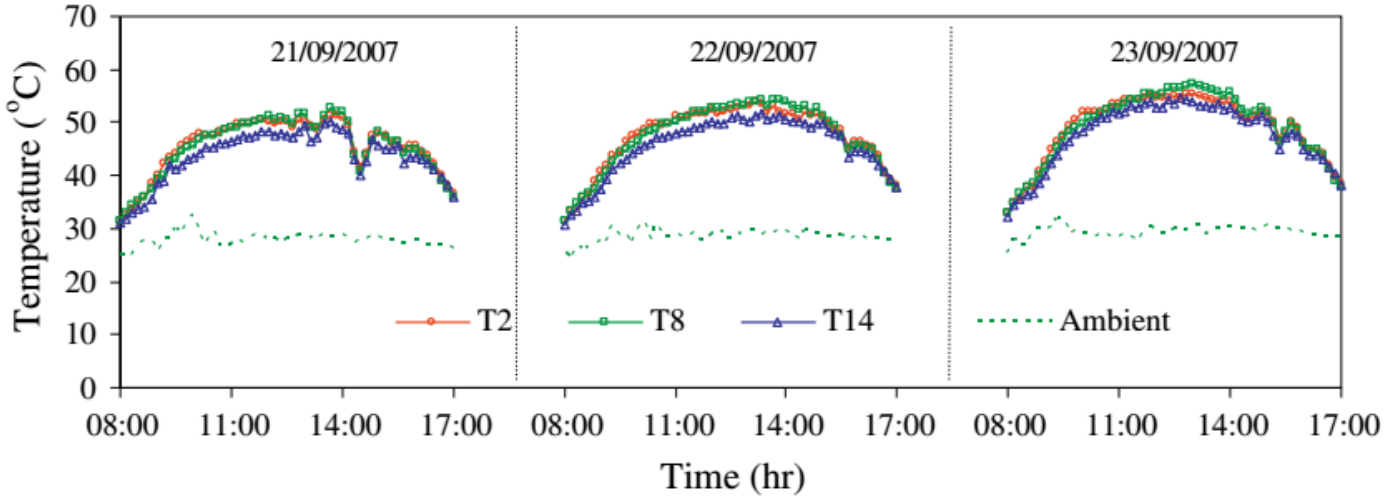
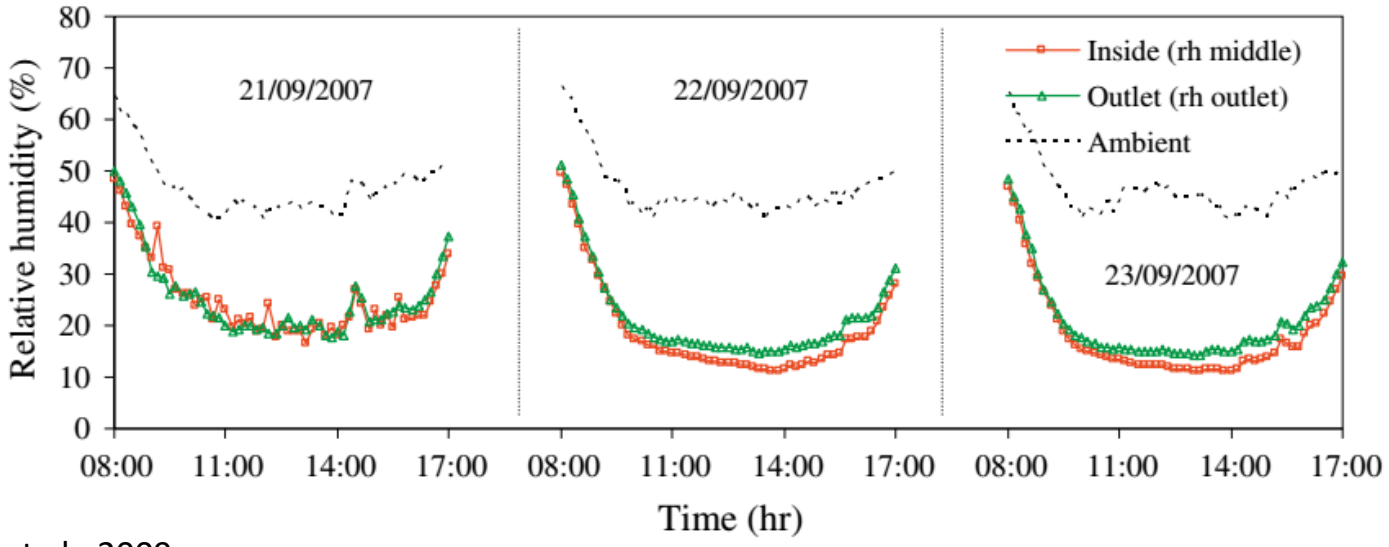


Fig. 4. Variations of solar radiation during a typical experimental drying run for peeled longan.

Source: Janjai et al., 2009





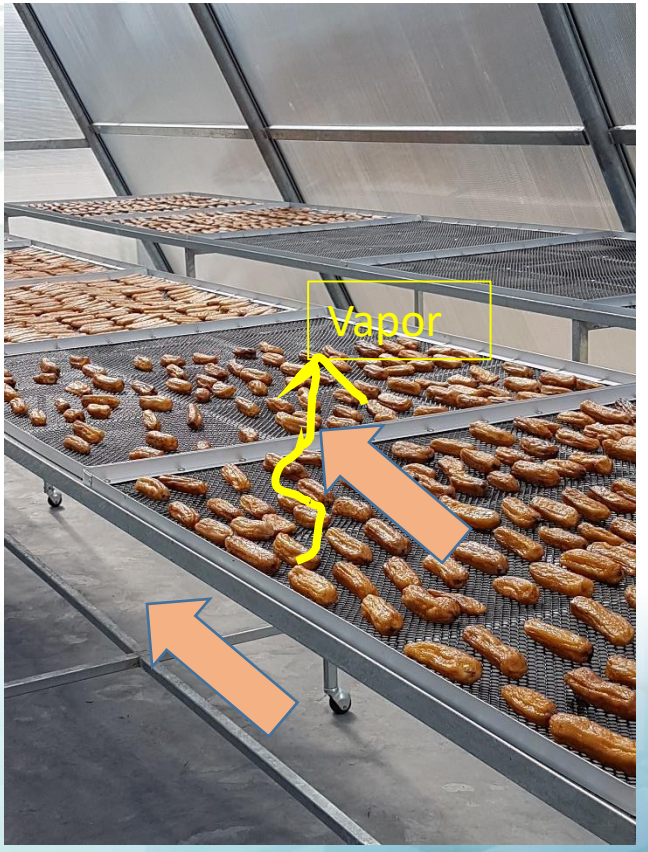
Source: Janjai et al., 2009

A parabolic solar dryer_performance

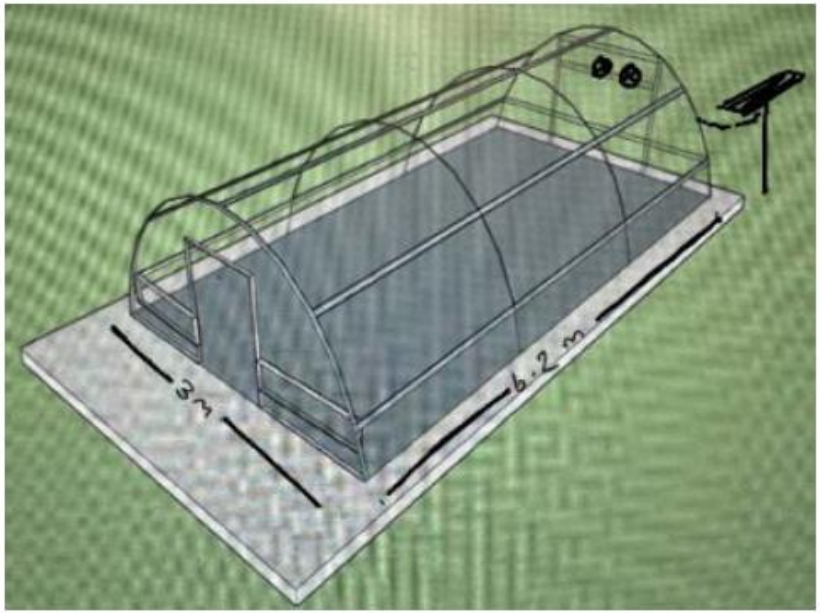
Mode of hot air flow

Over- and under- flow mode

Wire mesh trays



A parabolic solar dryer

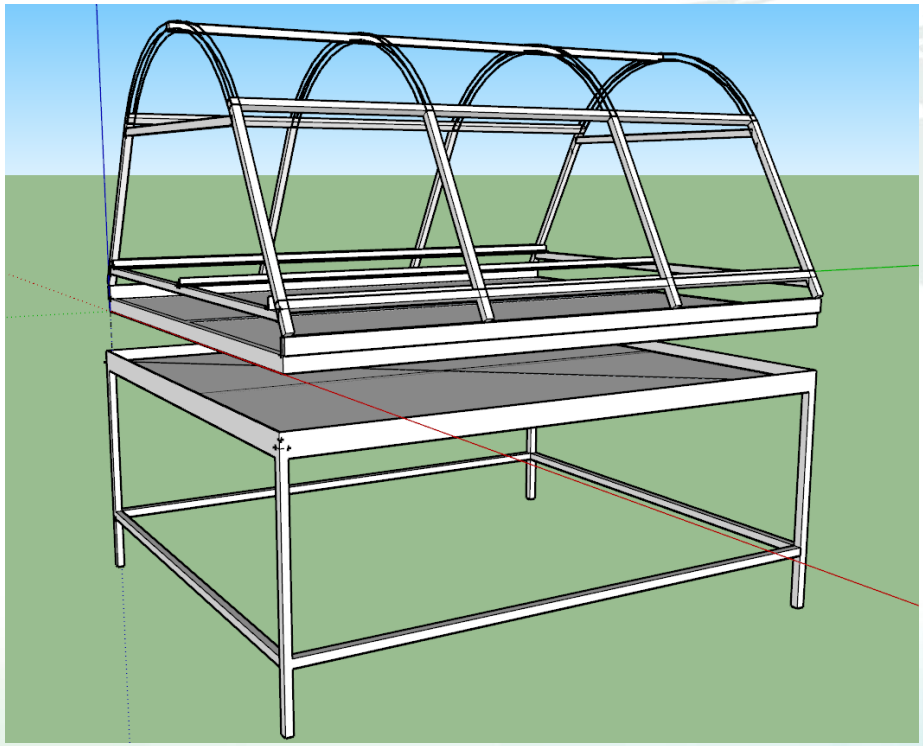


W = 3 m L = 6.2 m

A parabolic solar dryer

W = 3 m L = 6.2 m

A parabolic solar dryer_household type



W = 1.8 m L = 2.1 m

A parabolic solar dryer_household type

A parabolic solar dryer_with supplyment heat source, LPG

Integrating of a parabolic solar dryer with a production plant

Integrating of a parabolic solar dryer with a production plant

Application of a parabolic solar dryer in tropical fruits in Thailand

Application of a parabolic solar dryer in tropical fruits in Thailand_dried whole banana

Drying time

Sun drying 5-7 days

Solar drying 3-4 days

Application of a parabolic solar dryer in tropical fruits in Thailand_Banana roll or Banana sheet

Drying time

Sun drying 2 days

Solar drying 1.5 days

Application of a parabolic solar dryer in tropical fruits in Thailand_Banana stick

Application of a parabolic solar dryer in tropical fruits in Thailand

Drying time 3 days

Dried Tomato

Application of a parabolic solar dryer in tropical fruits in Thailand

Drying time 2-3 days

Dried Mango

No sugar added

No sulfur

Dried mango

Application of a parabolic solar dryer in tropical fruits in Thailand

Application of a parabolic solar dryer in tropical fruits in Thailand_pineapple

Allergen concern

NO SULFUR หรือ SULPHUR FREE

Drying time: Solar drying 3 days

Health concern

No sugar added, 0% Fat,

Application of a parabolic solar dryer in tropical fruits in Thailand

Drying time 1.5 - 2 days

Dried mulberry

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Original article

Influence of drying conditions on colour, betacyanin content and antioxidant capacities in dried red-fleshed dragon fruit (*Hylocereus polyrhizus*)

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Impact of drying temperature on color of dried red-flesh dragon fruit

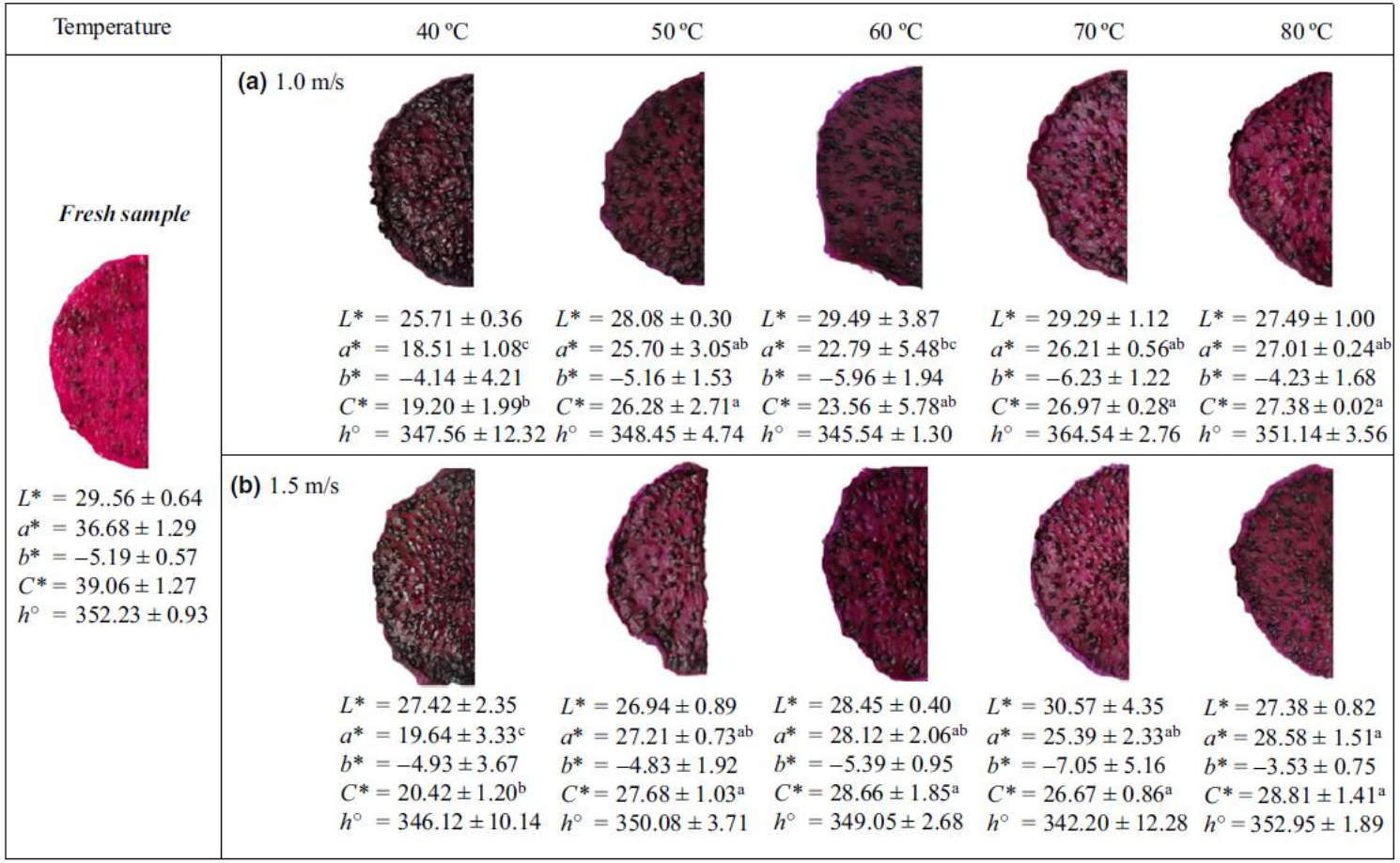


Figure 2 Visual comparison of red-fleshed dragon fruits in different drying conditions. (a) air velocity of 1.0 m s^{-1} and (b) air velocity of 1.5 m s^{-1}. [Colour figure can be viewed at wileyonlinelibrary.com]

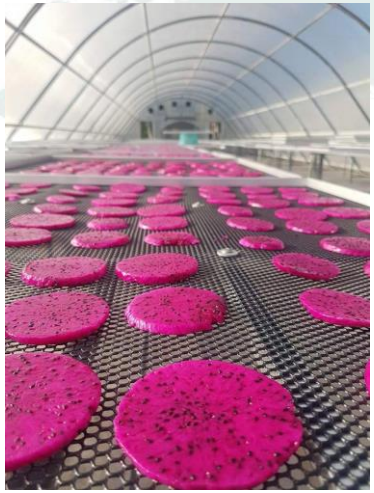
Impact of drying temperature on color of dried red-flesh dragon fruit

Table 1 Drying time, moisture content, water activity and drying rate constants of red-fleshed dragon fruits at different conditions*

Conditions			MC (%wb)	a_w	Page model			
Temp. (°C)	Air velocity (m s^{-1})	Drying time (h)	After drying	After drying	k (1 h^{-1})	n	R^2	RMSE
40	1.0	21.23	14.33 ± 0.59^{a}	0.539 ± 0.002^{a}	0.1122^{j}	1.252^{f}	0.997	0.012
40	1.5	12.22	14.93 ± 0.78^{a}	0.561 ± 0.022^{a}	0.1373^{h}	1.283^{e}	0.995	0.055
50	1.0	8.23	13.67 ± 0.21^{ab}	0.523 ± 0.030^{ab}	0.2097^{g}	1.343^{d}	0.995	0.047
50	1.5	6.83	11.36 ± 0.47^{abc}	0.494 ± 0.035^{abc}	0.3158^{f}	1.258^{f}	0.996	0.052
60	1.0	6.80	11.04 ± 0.96^{abc}	0.461 ± 0.016^{bcd}	0.3073^{f}	1.327^{d}	0.997	0.057
60	1.5	4.87	11.89 ± 3.25^{abc}	0.462 ± 0.064^{bcd}	0.4864^{d}	1.297^{e}	0.996	0.016
70	1.0	5.27	11.89 ± 2.32^{abc}	0.435 ± 0.034^{cd}	0.4569^{e}	1.346^{d}	0.998	0.049
70	1.5	3.73	10.90 ± 1.87^{abc}	0.443 ± 0.015^{cd}	0.5988^{c}	1.438^{a}	0.998	0.047
80	1.0	3.70	8.89 ± 0.04^{c}	0.402 ± 0.010^{d}	0.6572^{b}	1.406^{b}	0.998	0.051
80	1.5	2.80	9.84 ± 3.28^{bc}	0.399 ± 0.005^{d}	0.9354^{a}	1.373^{c}	0.999	0.054

Data are expressed as mean ± SD (n = 2).
R^2, Coefficient of determination; RMSE, Root mean square error.
*Significant (P < 0.05) differences within a column are denoted by different superscript letters.

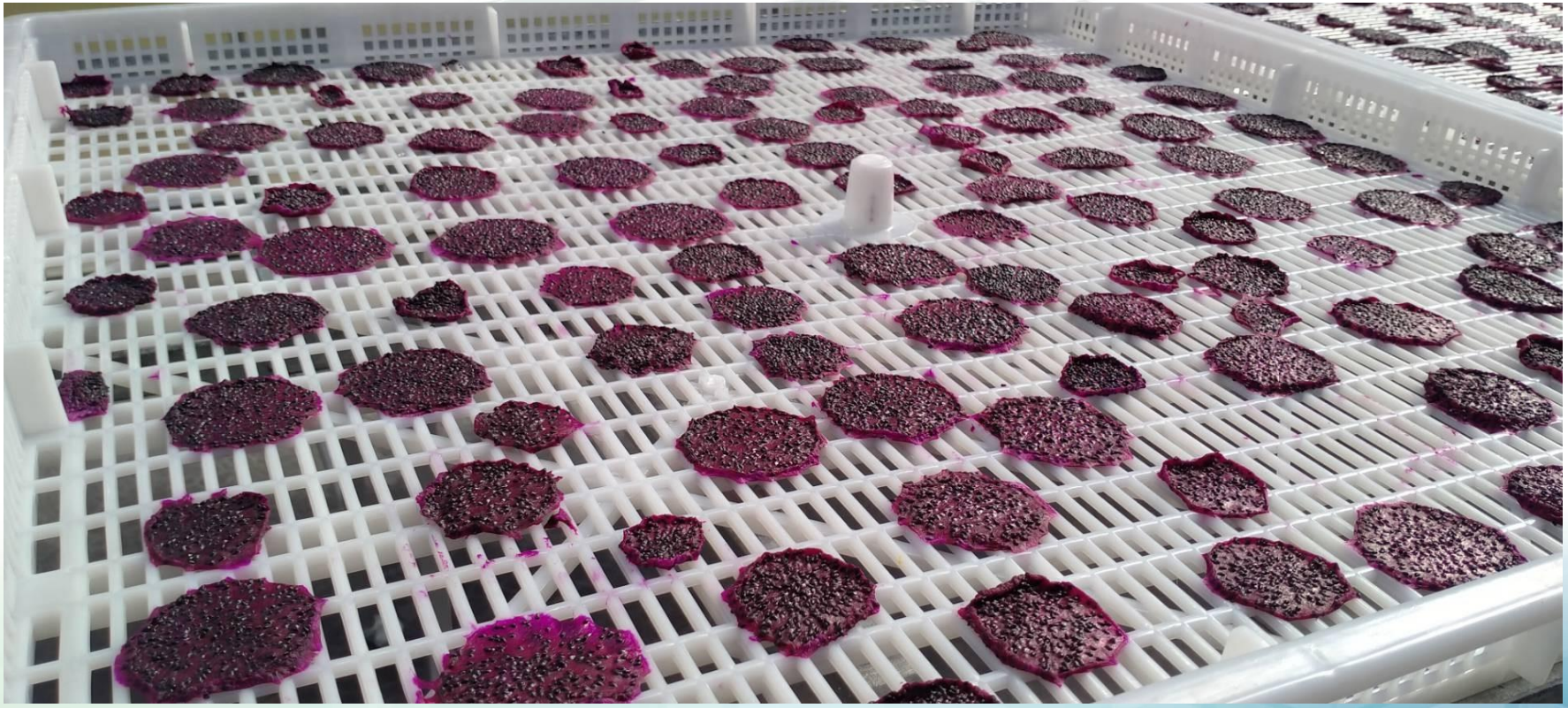
Application of a parabolic solar dryer in tropical fruits in Thailand



Drying time

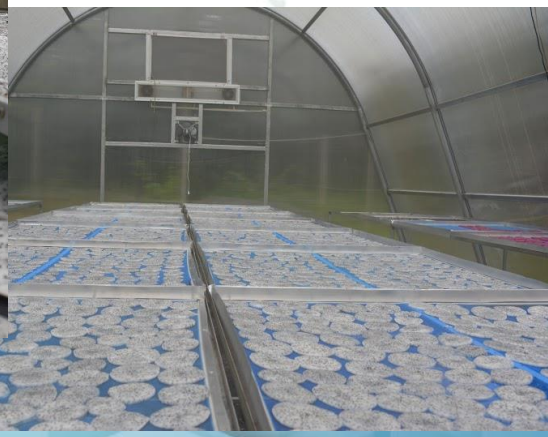
1.5 - 2 days

Application of a parabolic solar dryer in tropical fruits in Thailand



Dried dragon fruit

Application of a parabolic solar dryer in tropical fruits in Thailand



Dragon fruit

Application of a parabolic solar dryer in tropical fruits in Thailand

Dried coconut

Application of a parabolic solar dryer in tropical fruits in Thailand

Dried marian

Application of a parabolic solar dryer in tropical fruits in Thailand

Dried tamarind

	Moisture content	Water activity	Sweetness (TSS, °Brix)
Fresh	68.65%	0.97	25.7
Drying time			
Day 1	59.69%	0.95	31.7
Day 2	49.40%	0.93	42.4
Day 3	39.63%	0.84	54.9
Day 4	32.50%	0.74	65.5
Day 5	29.43%	0.65	70.4

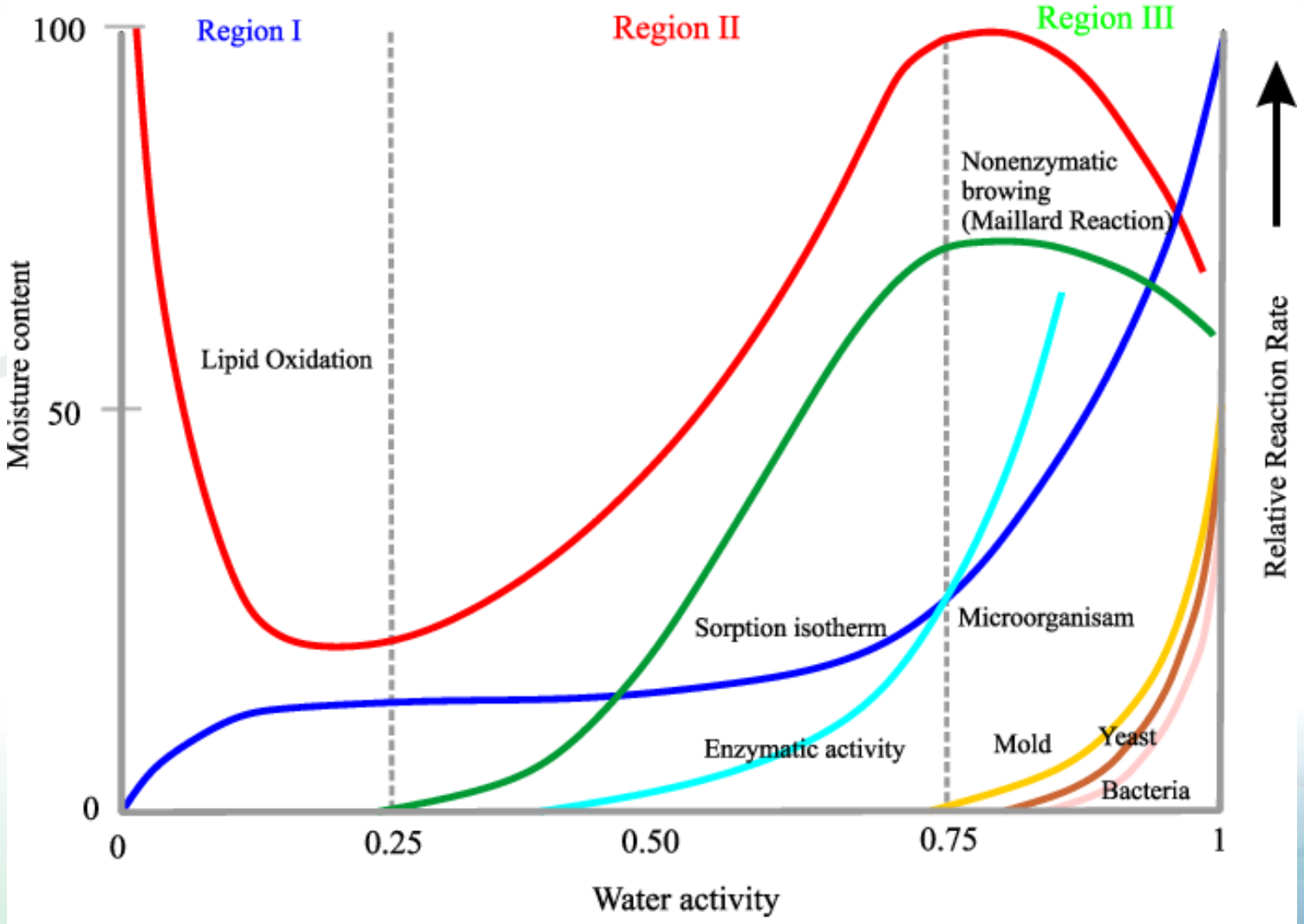


Fig. 1 Food stability map (Labuza et al., 1972)

General Process of Solar Dried Products

Raw materials: Fruits or Spices or Medicinal Plants

↓

Raw materials preparations: Selection, Cleaning, Washing, Sanitization,
Peeling, Trimming, Slicing,
Pretreatment (blanching or sugaring) etc.

↓

Drying or Dehydration: Greenhouse Solar dryer

↓

Dried Products

↓

Packaging and Storage

Drying Mango using a parabolic solar dryer

NATURAL

Solar DRIED MANGO

Mature Green mango

Ripening of mango

Drying Mango using a parabolic solar dryer

Optimum ripeness of mango

Wash

Drying Mango using a parabolic solar dryer

Air drying

Prepare the pretreatment solution

$CaCl_2$ 1%, citric acid 0.5% KMS (INS224) 300 ppm

Drying Mango using a parabolic solar dryer

Prepare the pretreatment solution

$CaCl_2$ 1%, citric acid 0.5% KMS (INS224) 300 ppm

drinking water 1 L

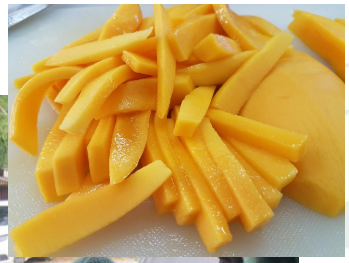
citric acid 5 g

calcium chloride ($CaCl_2$) 10 g

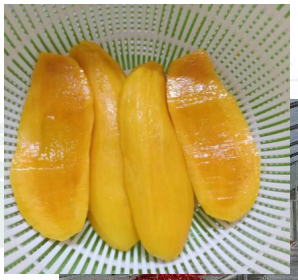
Potassium metabisulfite (KMS) 0.3 g

Soak in pretreatment solution 1 hours

Drying Mango using a parabolic solar dryer

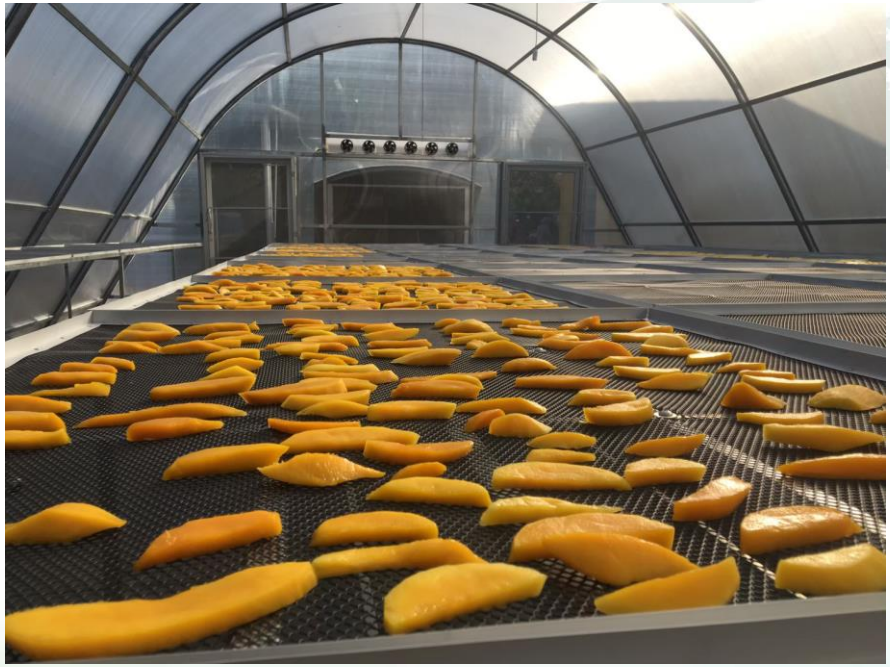




Peeling and slicing




Dry for 2-3 days depends on the solar radiation and the shape or thickness of mango slices

Drying Mango using a parabolic solar dryer



Dried Mango

Drying Mango using a parabolic solar dryer

Drying Mango using a parabolic solar dryer

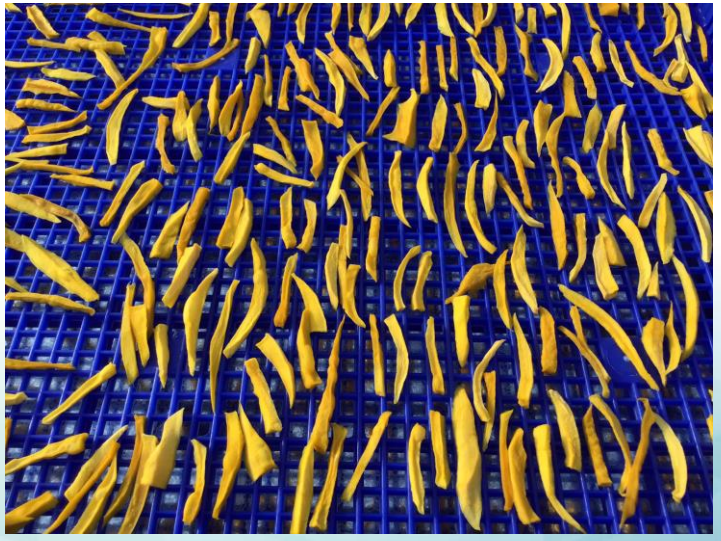
Dried Mango

Dry for 1-1.5 days

Solar Dried Mango _different shape of slices






Solar Dried Mango _different pretreatment

Dried Mango (No sulfur) added

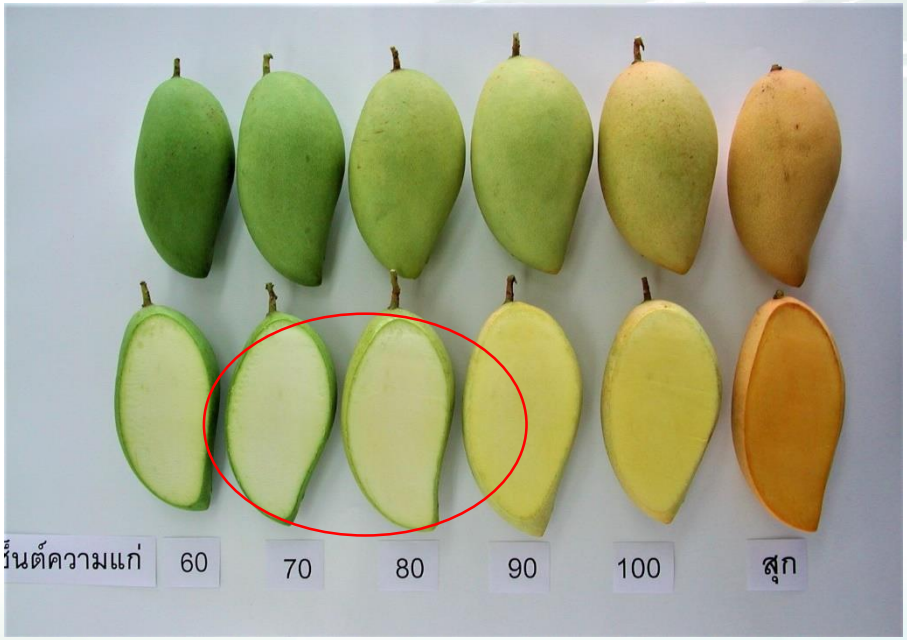
Dried Mango (Sulfur added)

Solar Dried Mango _different ripeness

Solar Dried Mango _impact of ripeness

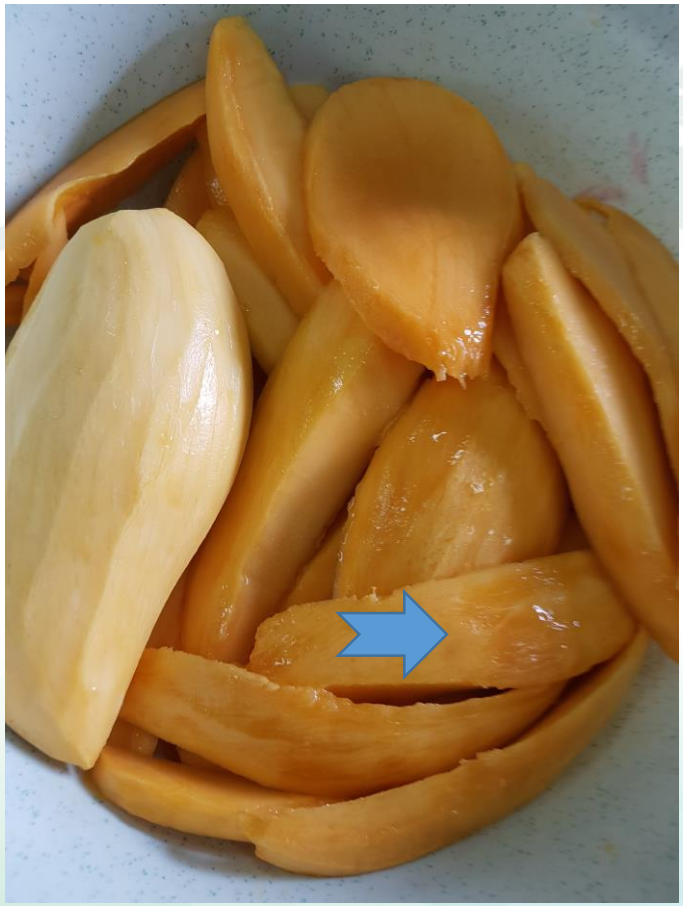
Over ripe

Solar Dried Mango _impact of ripeness



Immature or half ripe

Solar Dried Mango _impact of bruise tissue



Solar Dried Mango _impact of no pretreatment with sulfur

yeast growth

No further process

Banana sheet production






Banana sheet production

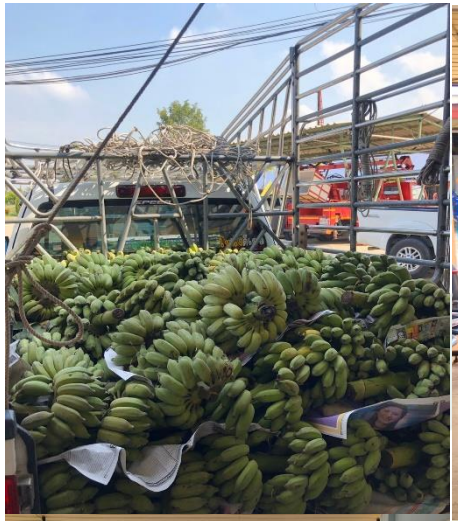
Banana sheet production

Dry for 1-2 days

Banana sheet production

Impact of banana variety on the formation of brown color of dried product

Dried Banana production_whole banana






Dried Banana production_ whole banana

Ripening

Dried Banana production_whole banana

Dried Banana production_whole banana

Dried Banana production_whole banana

Dried Banana production_whole banana

Day 1

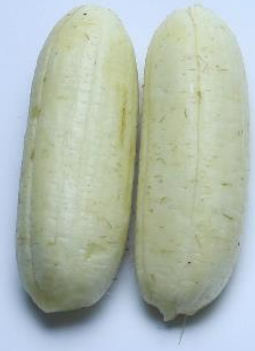
Day 3

Day 2

Day 4

Dried Banana production_whole banana

Dried Banana production_whole banana



กล้วยสด

ตากแดด 1 วัน

ตากแดด 2 วัน

ตากแดด 3 วัน

ตากแดด 4 วัน

ตากแดด 5 วัน

ทับแบน

Dried Banana production_whole banana

คุณภาพ	กล้วยน้ำว้าสด	ทำแห้งวันที่ 1	ทำแห้งวันที่ 2	ทำแห้งวันที่ 3	ทำแห้งวันที่ 4	ทำแห้งวันที่ 5 (ผลิตภัณฑ์กล้วยตาก)
น้ำหนัก	99.56±13.52	59.12±7.80	52.68±6.93	37.87±5.73	36.02±1.58	26.82±2.91
a_w	0.972±0.002	0.948±0.008	0.934±0.011	0.841±0.006	0.743±0.002	0.655±0.003
Brix	25.7±0.2	31.7±0.4	42.4±0.1	54.9±0.3	65.9±0.3	65.5±0.2
pH	4.74±0.02	4.67±0.01	4.59±0.08	4.75±0.005	4.6±0.005	4.87±0.02
ความชื้น (ฐานเปียก)	68.65±0.29	59.69.±1.39	49.40±0.14	39.63±2.35	32.56±1.19	29.43±1.09

คุณสมบัติทางกายภาพของกล้วยตากเมื่อทำแห้งกล้วยน้ำหนักมีแนวโน้มลดลง ค่าวอเตอร์แอกติวิตี้ลงลง

Dried Banana production_banana stick

Dried Banana production_banana stick

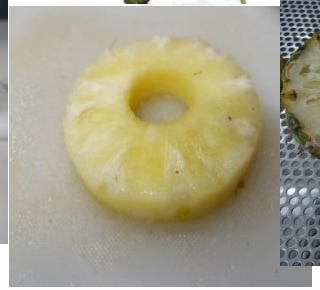
Drying 1-2 days

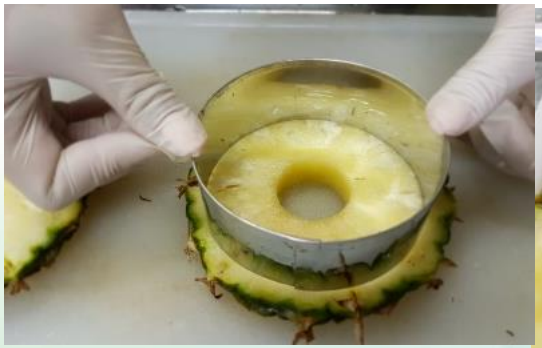
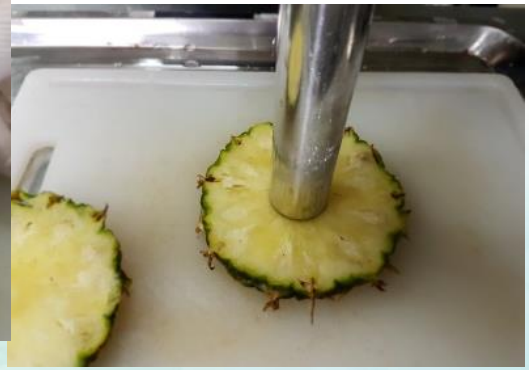
Dried pineapple production

Dried pineapple production






Dried pineapple production

Solar Dried pineapple _impact of ripeness

AITC course 2023 : The application of a parabolic greenhouse solar dryer together with raw material preparation techniques to extend shelf-life and enhance quality of agricultural products

Consumption of dried fruits

Topping of cracker

THANK YOU FOR YOUR ATTENTION