Microwave and Ultrasound Pre-treatments for 'Rocha' Pear: Impact on Drying Kinetics and Selected Quality Attributes

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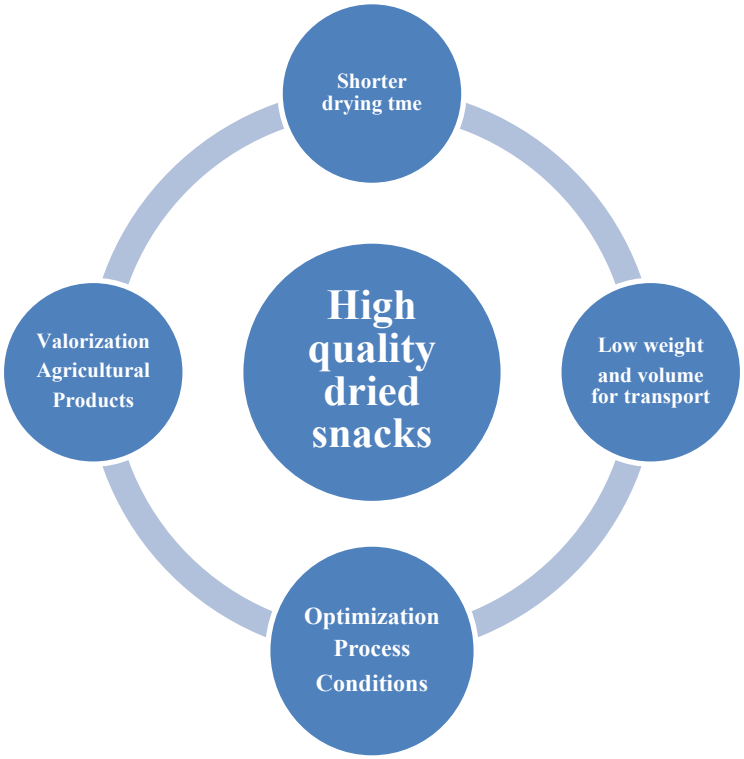
23rd International Conference on Food Fraud &Safety

Montreal, Canada

December 06-07, 2019

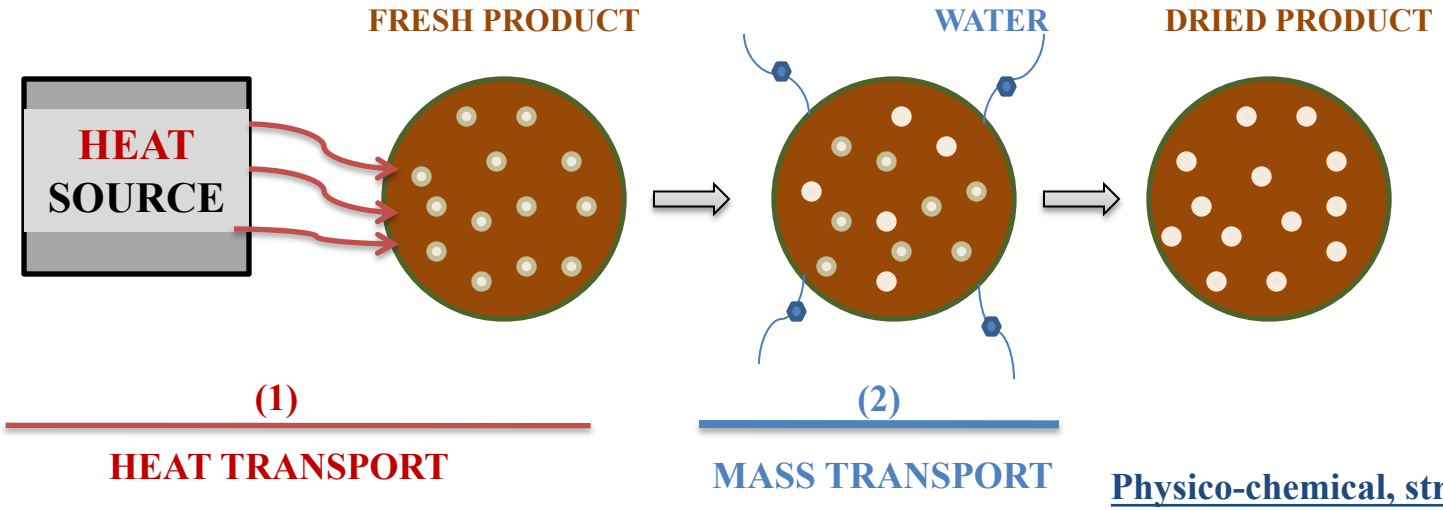
INDUSTRIAL APPLICATION



Dried snacks, currently available at market

DRYING PROCESS / AN OVERVIEW

- Drying is very important technology to improve food preservation.
- Hot air drying is very complex process characterized by two phenomena occuring simultaneously:



✓**Advantages**

- Improved the food stability and storage life
- Reduced the water and microbiological activity
- Minimized transportation cost and storage

Physico-chemical, structural, nuritional changes

- Texture and firmness
- Shape and size
- Shrinkage
- Colour
- Nutritional properties
- Sensorial characteristics

(Doymaz et al., 2010; Brasiello et ., 2013)

PRE -TREATMENTS BEFORE DRYING

Common Pre-treatments

- Immersion in chemical solutions (i.e sulphates, ascorbic, citric acid etc.) (Doymaz et al.,2010, Vega Galvez et al., 2008)
- ✓Osmotic solutions (Azoubel et al., 2009; Novakovic et al., 2011)
- Physical pre-treatments
- ✓Hot-water blanching (Niamnuy et al., 2014)
- ✓ Abrasive (Di Matteo et al., 2000; Adiletta et al., 2016)

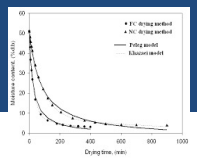
Innovative Pre-treatments

✓Ultrasound application as a pre-treatment
✓Microwave application as a pre-treatment

Why do we use these pre-treatments before drying?

Preservation colour and flavour
Minimization nutrient loss
Inhibition of enzymatic reactions
Reduced drying time
Good quality dried product

LAYOUT - OBJECTIVES



Optimization of innovative pretreatments - drying process conditions

Improvement of quality properties of selected fruits

Development of new mathematical models

Valorization of traditional fruits

Obtaining healthy-nutritive dried snacks

- **'Rocha' Pear**
- **'Terzarola Gialla' Peach**
- **'Annurca' Apple**

Collaboration with Catholic University, Porto
Prof. Cristina Silva's Research Group
6 months

Work Plan Development

'Rocha' Pear

PRE-TREATMENTS

✓Control Pear Slabs

✓Ultrasound Pre-treatment
35 kHz, 160-640 W,
28°C, 10 min

✓Microwave
Pre-treatment
2450 MHz, 600 W,
4 min

ANALYSIS

Drying Kinetics
Shrinkage
Colour
Total Phenolic Content
Antioxidant Activity
Texture
Rehydration Capacity
(30 °C)

RAW MATERIAL

"Rocha" Pear

Typical product in Portugal

Slab

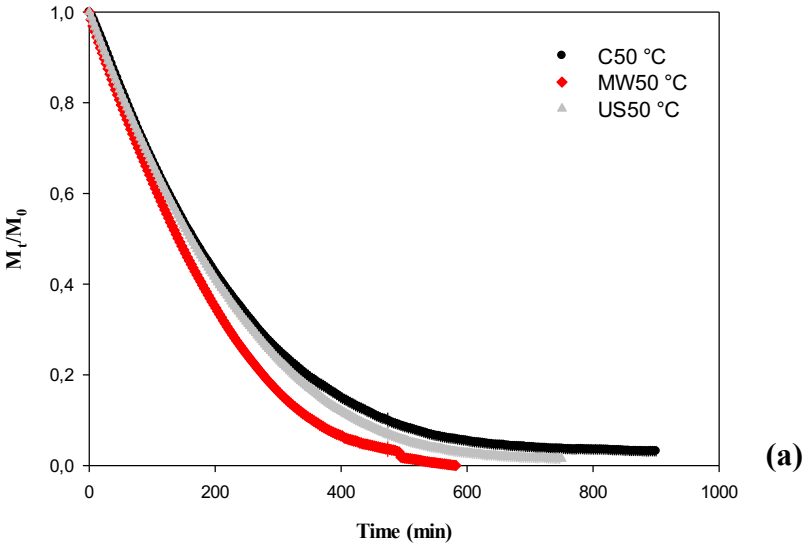
Thickness = 6 mm
Diameter = 38 mm

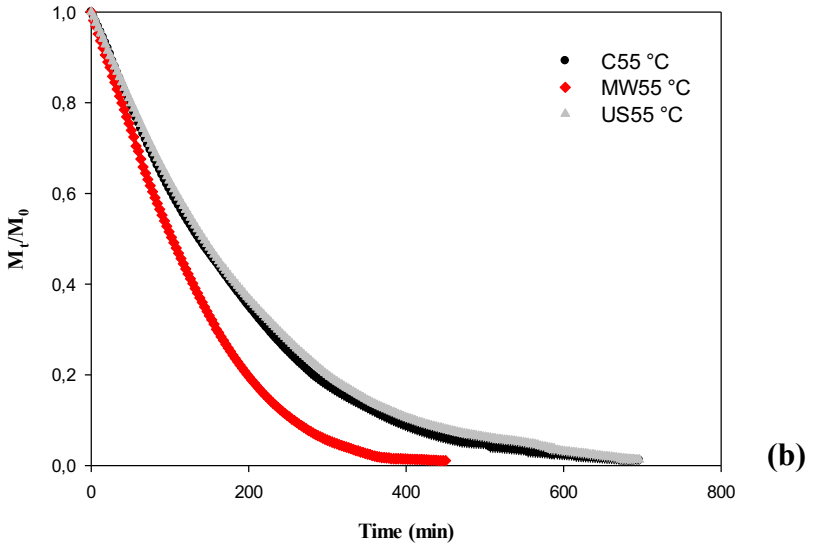
DRYING PROCESS

Convective
tray dryer
Temperatures:
50, 55, 60 °C
Air velocity: 0.75 m/s

Results of 'Rocha' Pear

Drying Kinetics





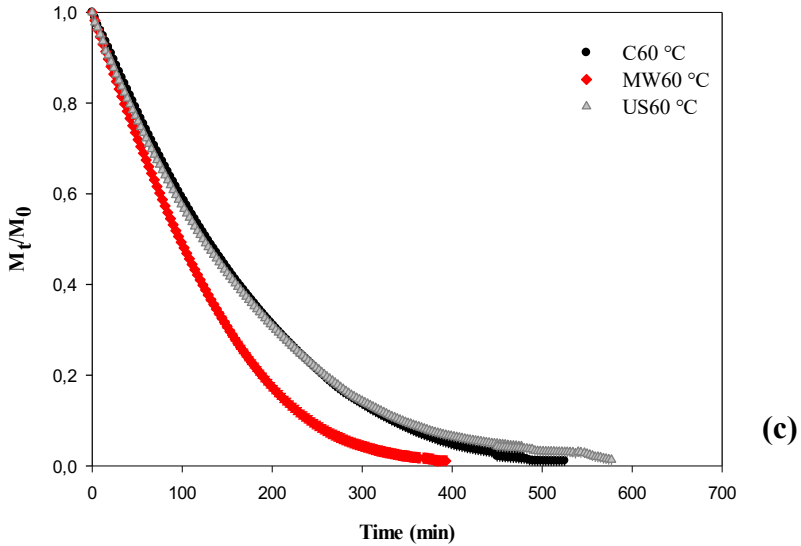


Fig.1. Experimental drying curves of control (C), microwave (MW) and ultrasound (US) pre-treated pear slabs dried at 50°C (a), 55°C (b), 60°C (c)

Results of 'Rocha' Pear

Drying Modeling: Emprical Models

Table 1. Model parameters of control, microwave and ultrasound pre-treated 'Rocha' pears dried at 60°C.

		SAMPLES		
Model Name	**Parameters**	**Control**	**Microwave**	**Ultrasound**
Newton	**k**	0.604 ± 0.013	0.851 ± 0.035	0.608 ± 0.007
Henderson and Pabis	**a**	1.074 ± 0.009	1.090 ± 0.016	1.041 ± 0.005
	k	0.646 ± 0.014	0.925 ± 0.038	0.632 ± 0.008
Page	**k**	0.188 ± 0.008	0.223 ± 0.011	0.314 ± 0.010
	N	1.220 ± 0.010	1.258 ± 0.011	1.124 ± 0.007

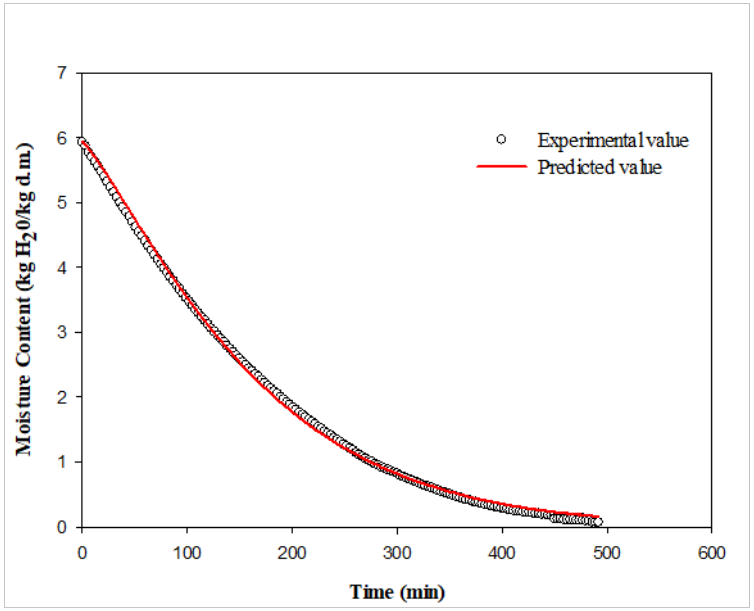
Results of 'Rocha' Pear

Drying Modeling: Emprical Models

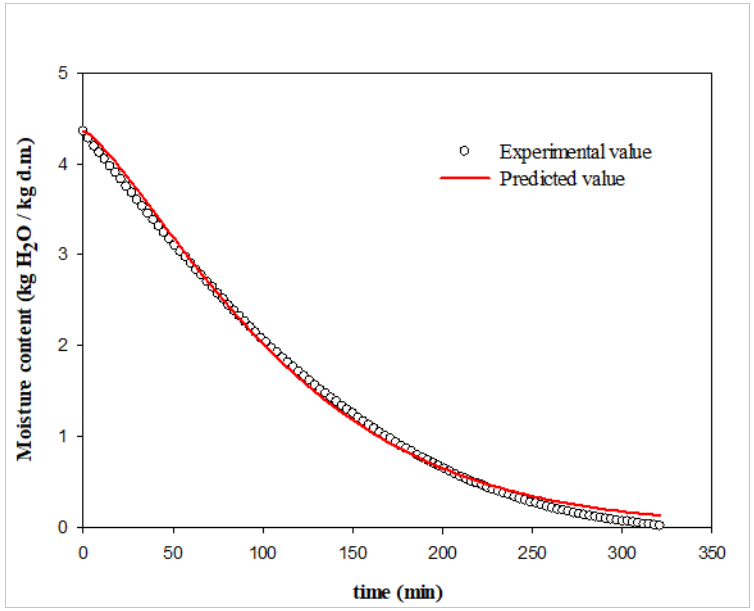
Table 2. Correlation coefficeints of control, microwave and ultrasound pre-treated 'Rocha' pears dried at 60°C.

		SAMPLES		
Model Name	**Correlation Coefficients**	**Control**	**Microwave**	**Ultrasound**
Newton	R^2	0.986	0.974	0.994
	s	0.204	0.210	0.128
Henderson and Pabis	R^2	0.901	0.983	0.996
	s	0.161	0.173	0.107
Page	R^2	0.999	0.999	0.999
	s	0.064	0.054	0.005

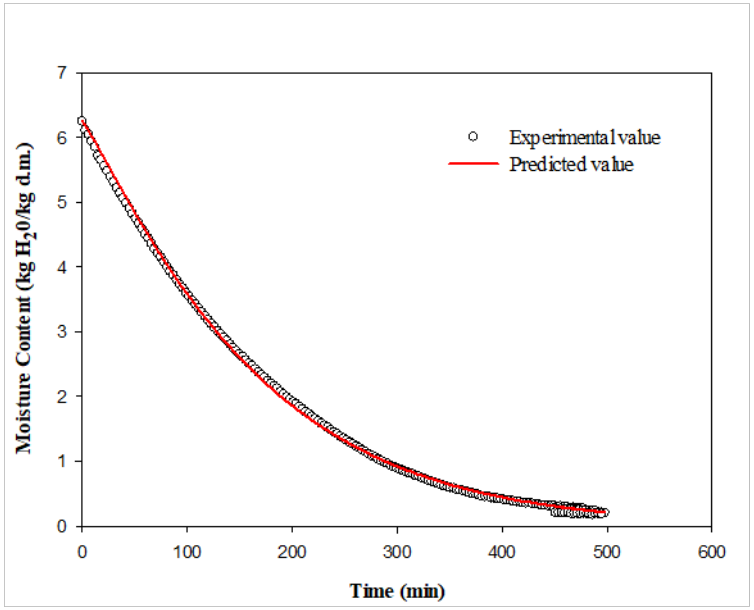
Results of 'Rocha' Pear



(a) Control



(b) MW



(a) US

Fig.2. Experimental and predicted drying curves of control (C) (a), microwave (MW) (b) and ultrasound (US) (c) pre-treated pear slabs dried at 60°C

Results of 'Rocha' Pear

Colour

Table 3. Colour parameters for fresh, control (C), microwave (MW) and ultrasound (US) pre-treated 'Rocha' pears dried at 60°C.

Sample	L*	WI	ΔE
Fresh	78.60 ± 0.90^{e}	72.11 ± 1.00^{f}	–
C60 °C	75.06 ± 0.80^{cde}	64.96 ± 0.67^{d}	8.13 ± 0.71^{bc}
MW60 °C	60.53 ± 0.68^{b}	52.88 ± 0.95^{b}	$14.91 \pm 0.8e^{b}$
US60 °C	**79.05 ± 0.25^{e}**	**70.96 ± 0.21^{f}**	**3.86 ± 0.23^{a}**

L* - Lightness WI - White index ΔE - Total colour difference

Results of ‘Rocha’ Pear

Colour

Fresh ‘Rocha’ Pear Slab

Dried ‘Rocha’ Pear Slabs at 60 °C

Control | Microwave | Ultrasound

Results of 'Rocha' Pear

Shrinkage

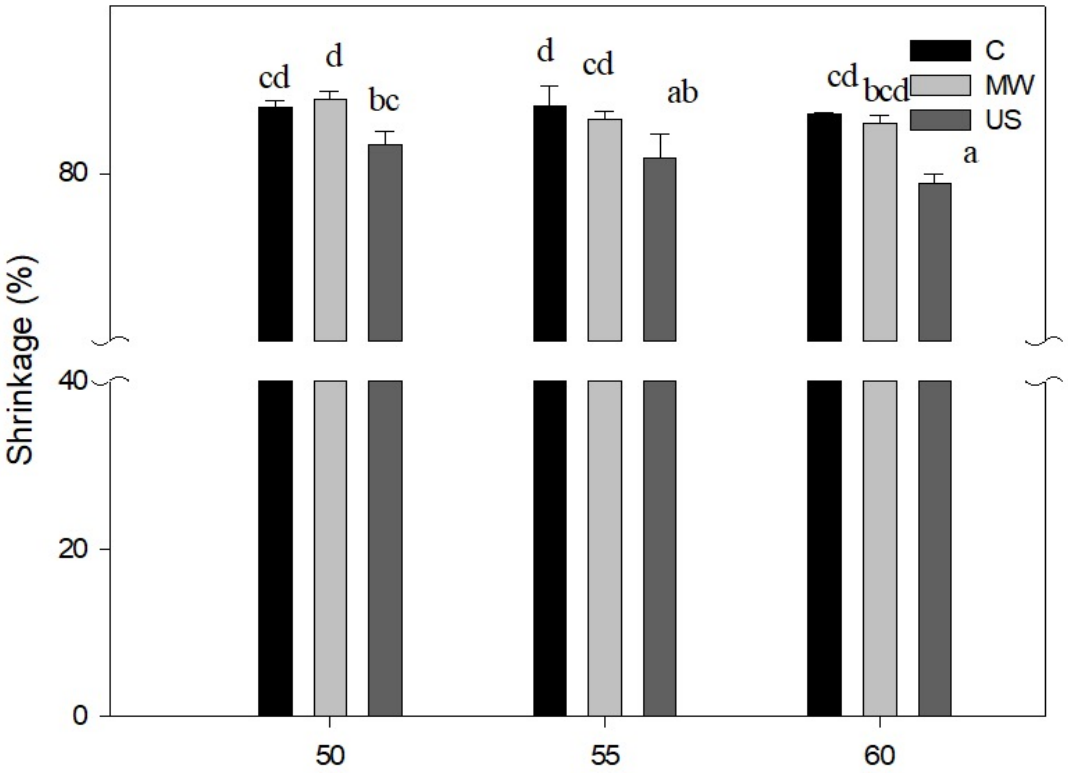


Fig.3. Shrinkage of control (C), microwave (MW) and ultrasound (US) pre-treated pears dried at 50, 55 and 60 °C

✓The lower drying temperature resulted in the increasing of shrinkage in pear samples.

✓Ultrasound treated pears at drying temperature of 60 °C produced less shrunk (79. 62%) pears, showing that that this combined drying method (US 60 °C) may be more effective on the shrinkage phenomenon due to protection of dried pear cell wall and tissue structure.

Results of 'Rocha' Pear

Total Phenolic Content

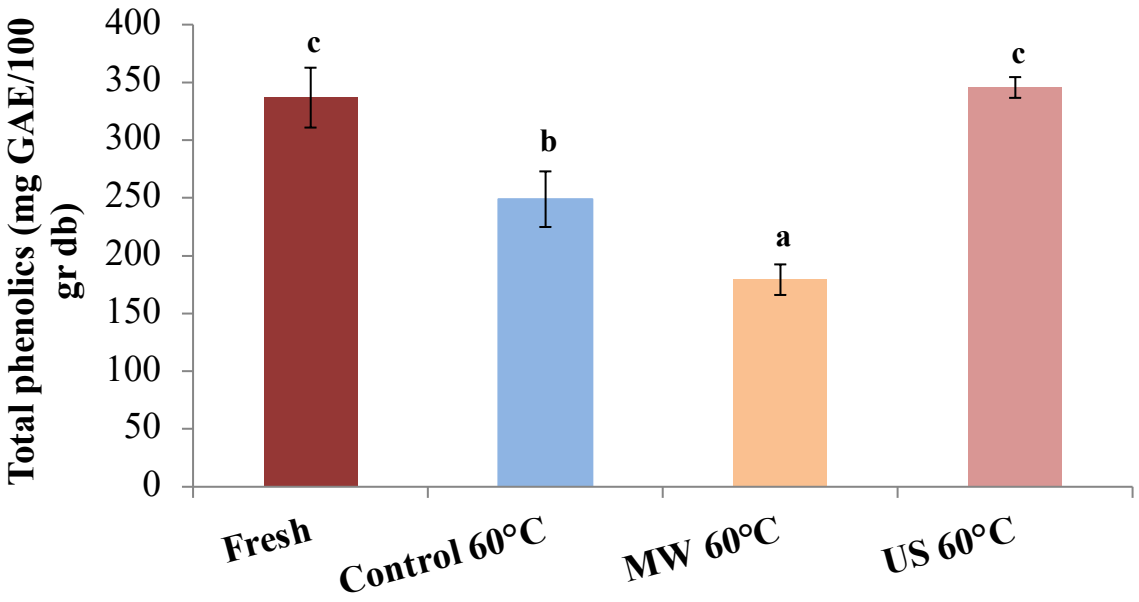


Fig.4. Total phenolics of fresh, control, microwave (MW) and ultrasound (US) pear samples dried at 60 °C

✓The experiments demonstrated that drying temperature and microwave and ultrasound pre-treatments had remarkable effect on the total phenolic content of pear samples.

✓Based on these results, the combination of ultrasound pre-treatment with higher drying temperature of 60 °C affected positively on the total phenolic content of pears.

Results of 'Rocha' Pear

DPPH radical scavenging activity

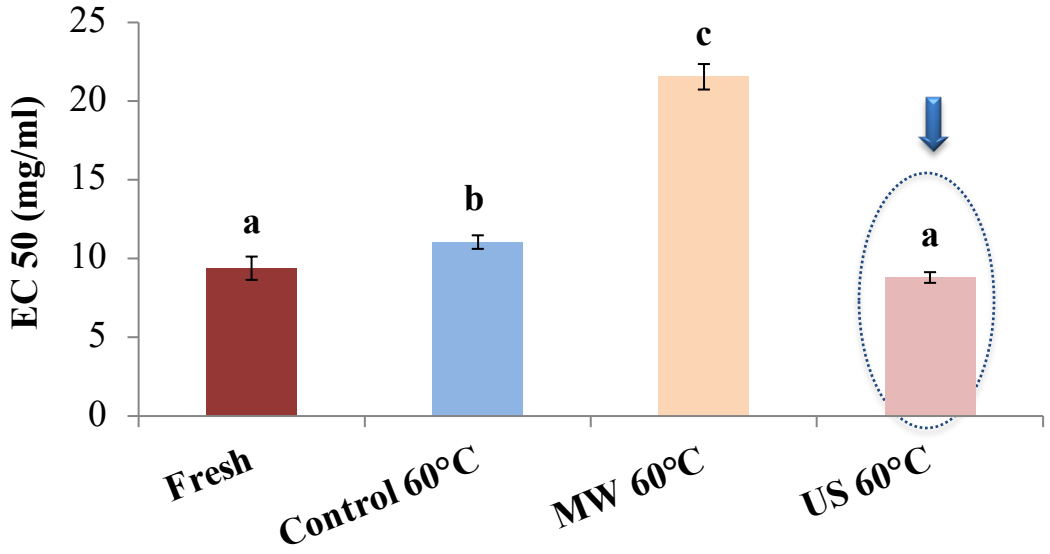


Fig.5. Antioxidant activity of fresh and dried pears at 60 °C)
(The lowest EC_{50} values correspond to higher antioxidant activity)

✓In this case, this proper combined drying method (ultrasound treatment and higher drying temperature of 60 °C) may be efficient, which can preserve the antioxidant activity and phenolic compounds in 'Rocha' pear samples.

Results of 'Rocha' Pear

Texture

Table 4. Textural attributes of control (C), microwave (MW) and ultrasound (US) pre-treated 'Rocha' pears dried at at 50, 55 and 60°C.

Sample	Hardness (g)	Springiness	Cohevesiness	Chewiness (g)
C50 °C	2163.35 ± 148.8^{bc}	0.751 ± 0.01^{a}	0.655 ± 0.04^{ab}	1037.33 ± 60.96^{abc}
MW50 °C	**3222.27 ± 113.3^{d}**	0.800 ± 0.01^{a}	0.615 ± 0.03^{ab}	**1571.30 ± 71.09^{d}**
US50 °C	2354.18 ± 73.13^{c}	0.796 ± 0.01^{a}	0.666 ± 0.91^{ab}	1279.54 ± 61.18^{cd}
C60 °C	1437.14 ± 113.60^{a}	0.760 ± 0.01^{a}	0.670 ± 0.00^{b}	736.91 ± 9.01^{ab}
MW60 °C	2217.86 ± 223.77^{bc}	0.790 ± 0.00^{a}	0.610 ± 0.01^{ab}	1098.64 ± 167.61^{bcd}
US60 °C	1859.20 ± 145.03^{ab}	0.750 ± 0.00^{a}	0.630 ± 0.02^{ab}	885.69 ± 105.20^{ab}

Results of 'Rocha' Pear

Rehydration Capacity

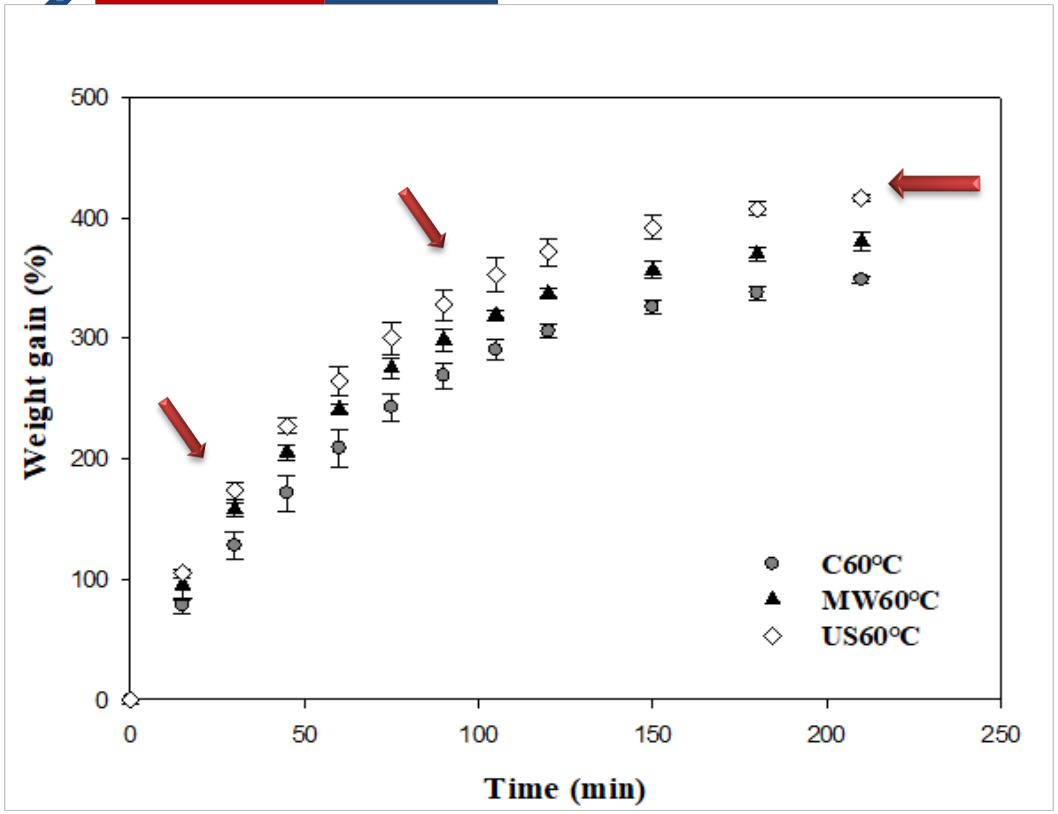


Fig.6. Rehydration kinetics of control (C), microwave (MW) and ultrasound (US) pre-treated pears dried at 60 °C

- **Rehydration** is an important property used for understanding the quality of dehydrated products.

Re-hydrated Products

- Milk products
  - •Yogurt
  - •Ice-cream
  - •Smoothie
- Bakery products
- Instant products
- Fruit tea - Infusion
- Liqueur

Results of ‘Rocha’ Pear

After Rehydration Process

Control

Microwave

Ultrasound

Dried ‘Rocha’ Pear Slabs at 60 °C

Rehydrated ‘Rocha’ Pear Slabs at 30 °C

FINAL REMARKS

✓The choice of appropriate pre-treatments and drying methods are one of the most important key factors of obtaining the high quality dried snacks in dehydrated food industry.

✓The impacts of each pre-treatment and drying method are depend on the food product and its market value.

✓From this viewpoint, the optimization of pre-treatment and drying conditions contribute to improve the overall quality attributes of evaluated fruits.

✓'Rocha' pear drying process were influenced by used **different pre-treatments** and **drying temperatures**.

FINAL REMARKS for 'Rocha' Pear

✓Microwave pre-treated samples had shorter drying time at each investigated drying temperatures.

✓On the other hand, microwave pre-treated dried samples indicated the lower overall quality attributes.

✓The combined application ultrasound pre-treatment and higher drying temperature of 60 °C seems to be promising technique for the overall better quality dried pear snacks.

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Microwave and Ultrasound Pre-treatments for 'Rocha' Pear: Impact on Drying Kinetics and Selected Quality Attributes, Begüm Önal, Giuseppina Adiletta, Marisa Di Matteo, Paola Russo, Ines N. Ramos, Cristina L.M. Silva, 23rd International Conference on Food Fraud & Safety, Montreal, Canada, 2019, December, Oral Presentation (accepted)

Many thanks for your attention.