Effect of different drying temperatures on the moisture, content of phytochemical constituents and technological properties of Peniche coast seaweeds

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INTRODUCTION

Seaweeds have increasingly been used as food due to their rich chemical and nutritional composition, particularly as high supply of essential nutrients to the human body such as protein, minerals, vitamins and dietary fiber and non-nutrient components such as polyphenols.

However, the availability of fresh seaweeds is scarce and drying methods have been used to stabilize and preserve these products. As such, it is of crucial importance to understand how the drying conditions may affect the properties of seaweeds.

OBJECTIVES:

The aim of this study was to understand the effect of different drying conditions, dry-bulb temperature of 40 °C and 60 °C, on several seaweeds species from the coast of Peniche: *Fucus spiralis*, *Codium tomentosum* and *Corallina officinalis*. The effect of drying temperatures on the phytochemical compounds of seaweed was also evaluated.

MATERIAL & METHODS

Fresh *Fucus spiralis*, *Codium tomentosum* and *Corallina officinalis* samples were collected from Peniche coast (Fig. 1), Portugal and stored at -20°C until analysis.

Figure 1. Peniche satellite view, 39°22'11.4"N 9°23'10.2"W.

Drying procedure: Hot air drying

Samples were dried at two different temperatures using a Tray drier (Fig.2): 40°C (0.99 $m.s^{-1}$ air velocity, relative humidity of 23%) and 60 °C (0.99 $m.s^{-1}$ air velocity, relative humidity of 11.75%) until they reached constant weight. The final moisture content of each sample was measured in order to calculate the moisture at each weighing interval. Drying tests were replicated ten times at each inlet air temperature and averages are reported.

Figure 2. Tray drier.

Dried seaweeds characterization:

- Moisture content (AOAC, 2000)
- Water activity
- Color measurement $\Delta E^* = \sqrt{(\Delta a^2 + \Delta b^2 + \Delta L^2)}$

Technological properties:

Water holding capacity (WHC)
- According to Sakthivel and Devi, 2015.

Oil holding capacity(OHC)
- According to Sakthivel and Devi, 2015.

Swelling capacity (SWC)
- According to Sakthivel and Devi, 2015.

Rehydration analysis
- Rehydration ratio (RR) according to Seremet et al., 2016.
- Rehydration capacity represented as percentage of water gain according to Maskan et al., 2001.

Extraction and phytochemicals determination:

- The extraction of phenolic compounds from seaweeds was carried out with water/ethanol (3:1 w/v) solution (Augusto et al., 2016).
- Total phenolic content, DPPH free radical-scavenging activity and oxygen radical absorbance capacity (ORAC) (Augusto et al., 2016; Wang et al., 2009).

RESULTS

- The shortest drying times were obtained using a dry-bulb temperature of 60 °C (Fig.3).
- Drying process at 60 °C allowed to obtain seaweeds with both lower moisture content and water activity (Fig.3).

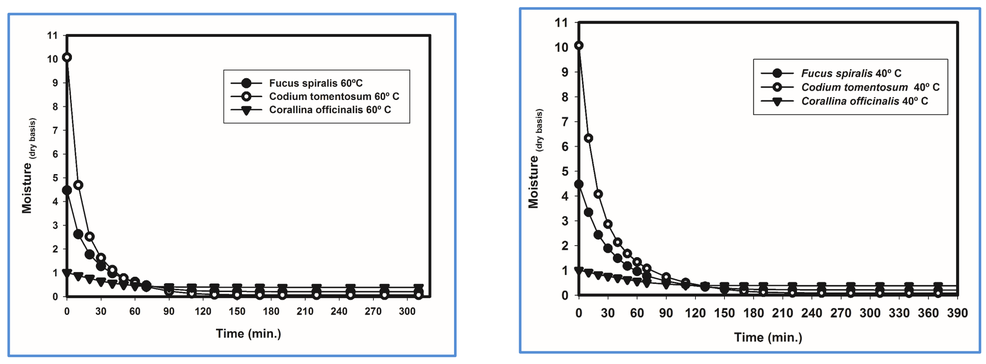


Figure 3. Typical drying curves for (a) *Fucus spiralis*, (b) *Corallina officinalis* and (c) *Codium tomentosum* at 40 °C and 60 °C.

- The dried seaweed instrumental color showed lower values of L*compared to fresh samples (Table 1).
- The drying of *Corallina officinalis* at 60 °C causes the highest color changes (Table 1).

Table 1. Color changes and photos of fresh and dried seaweeds.

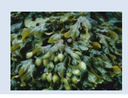
	F. spiralis	***C. officinalis***	***C. tomentosum***
Fresh seaweeds			
After drying at 60°C			
ΔE	11.44 ± 4.40	15.95 ± 2.74	4.31 ± 2.23
After drying at 40 °C			
ΔE	13.06 ± 4.49	13.06 ± 4.49	3.86 ± 2.92

Table 2. Effect of drying temperatures in studied technological properties of dried seaweeds.

Dried seaweed	**Effect of drying temperatures in technological properties of dried seaweeds**			
	WHC	OHC	SWC	Rehydration analysis
Fucus spiralis	Higher values at 40 °C drying.	Higher values at 40 °C drying.	No effect.	No effect.
Corallina officinalis	No effect.	No effect.	Higher values at 60 °C drying.	No effect.
Codium tomentosum	No effect.	No effect.	Higher values at 60 °C drying.	No effect.

- The drying process has no significant effect on phytochemicals compounds.

CONCLUSIONS

- Drying temperatures and dried seaweeds characterization was performed in the present work. Also technological properties of dried seaweeds were studied to achieve the best drying temperature.
- In this work, it was concluded that higher drying temperature conditions have higher impact on the studied parameters, possibly due to a higher physical and chemical damage in the algae tissues.

Acknowledgements: This study had the support of Fundação para a Ciência e Tecnologia (FCT), through the strategic project UID/MAR/04292/2013 granted to MARE

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