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Drying Kinetics and Characterization of Dried Osmotically Pretreated Cassava (*Manihot esculenta*)

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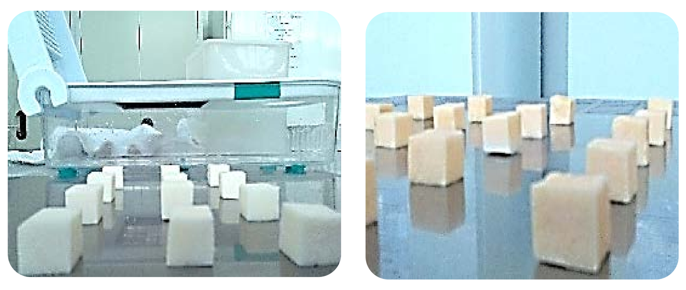
Introduction

- Drying is conducted to arrest the rapid post-harvest physiological deterioration of cassava.
- Osmotic dehydration (OD) as a pre-drying treatment of cassava is recommended because it is simple, cost effective, and requires low energy input.
- Important drying phenomena can be explained mathematically by the drying kinetics such as moisture ratio (MR), drying rate (DR) and diffusivity.
- Optimization of drying parameters by response surface methodology (RSM).
- Physicochemical properties of cassava, such as total carotenoids content (TCC), total cyanogenic potential TCP) and microstructure provide information on the final product.

Materials & Methods



Dehydration: 11 x11 x 10 mm
5 h, 70 °Brix salt-sugar solution, 45 °C, 10:1 w/w

DRYING: temperatures (50, 65, 80 °C)
air velocities (0.5, 0.9, 1.3 m/s)

OPTIMIZATION: 3-level factorial experiment design
Variables: temperature, air velocity
Responses: dryer energy consumption, shrinkage, drying energy, drying time, diffusivity.

Milling, Sieving (355 µm)

- MR & DR - modeled by thin-layer drying models: Page, logarithmic, Newton and Henderson-Pabis, Peleg
- Microstructure - scanning electron microscope (SEM)
- Shrinkage – change in volume of the cubes
- TCP – picrate paper protocol
- TCC - spectrophotometric quantification.

Results

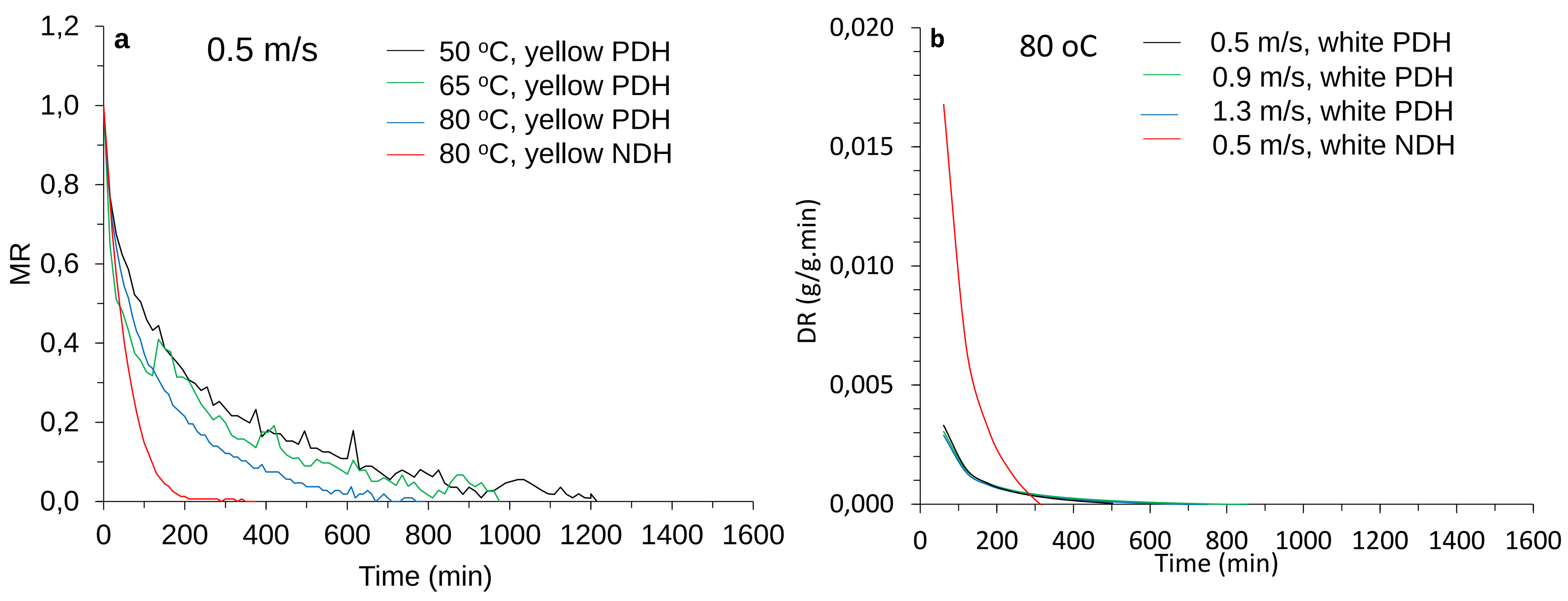


Fig 1. Effect of temperature on MR of PDH and NDH yellow cassava (a) and effect of air velocity on DR of PDH and NDH white cassava (b)

Table 1. Optimization of drying conditions for white and yellow cassava cubes and validation

	Temperature	Air velocity	Dryer Energy	Maximum Shrinkage	Diffusivity shrinkage	Diffusivity without shrinkage	Drying energy	Drying time to 10% MC wb
	(° C)	m/s	KW.h	%	m^2/s	m^2/s	kW.h	min
White								
Predicted	80.00	0.50	4.1	30.4	7.1×10^{-10}	9.1×10^{-10}	74.1	177.4
Validated	80.00	0.50	3.1	30.4	7.5×10^{-10}	9.5×10^{-10}	50.8	190.0
Experimental	80.00	0.50	3.8	30.7	7.4×10^{-10}	9.4×10^{-10}	67.3	181
Yellow								
Predicted	80.00	0.50	3.9	**	7.6×10^{-10}	10.0×10^{-10}	67.9	197.9
Validated	80.00	0.50	3.8	**	6.6×10^{-10}	9.0×10^{-10}	53.2	195.0
Experimental	80.00	0.50	3.9	35.1	7.7×10^{-10}	10.2×10^{-10}	68.9	171

- The optimal conditions for drying the PDH cassava was at a temperature of 80 °C and air velocity of 0.5 m/s.
- The response models were significant ($P < 0.0001$ to 0.0142), lack of fit ($P =$ 0.1605 to 0.2266) was insignificant.
- MR was best fit by the Newton model. Increasing temperature decreased MR but air velocity had no effect.
- DR was best fitted to Peleg model and occurred only in one falling rate. DR increased with temperature and air velocity. Diffusivity followed same trend.
- OD and drying reduced shrinkage by about 50 %, and increase in temperature and air velocity resulted in increased shrinkage.
- TCP significantly reduced by about 50 - 60 %.
- Microstructure of PDH and NDH cassava cubes show that starch granules were altered and cell wall structure was ruptured by OD.
- However, TCC of the PDH flour was significantly reduced to 15 – 36 %, reducing with temperature but increasing with air velocity.

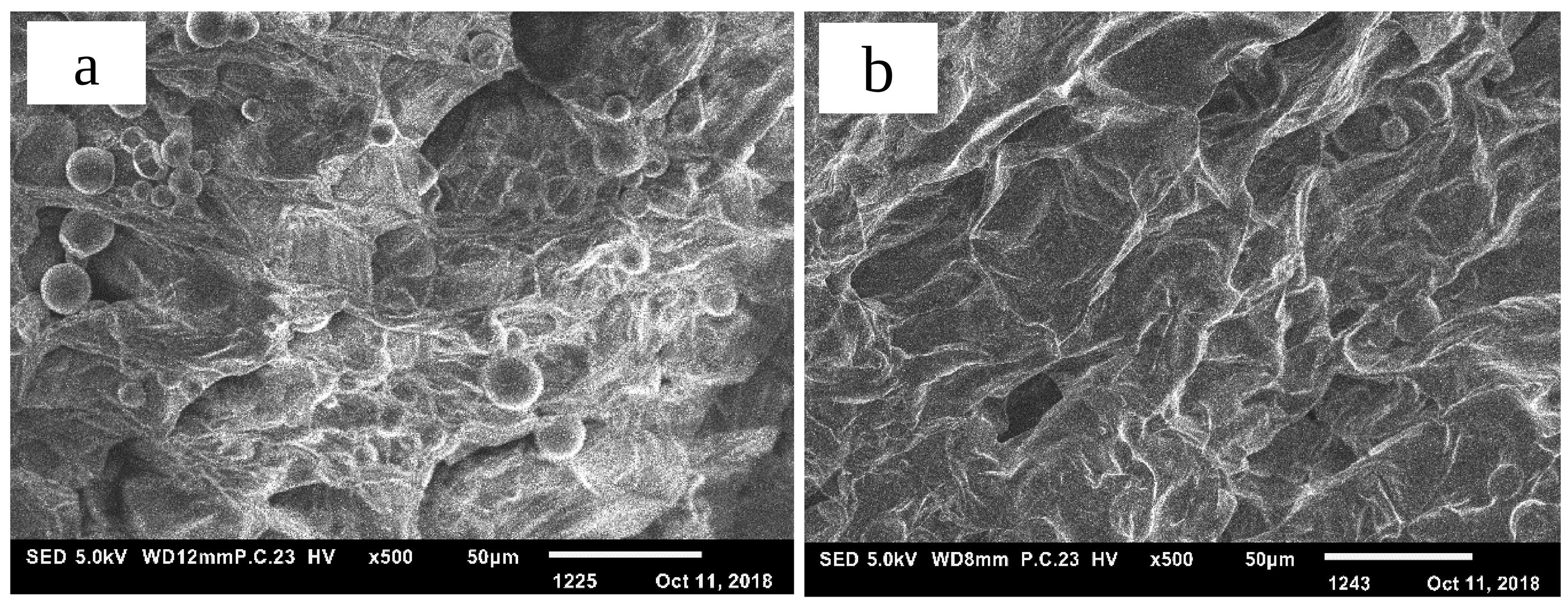


Fig 2. Microstructure of NDH (fresh) cassava (a) and PDH cassava (b) dried at 80 °C, 0.5 m/s

Conclusions

- The drying conditions influenced the drying kinetics and physicochemical properties of the cassava varieties.
- The varieties dried optimally at temperature of 80 °C and air velocity of 0.5 m/s.
- Osmotic dehydration prior to drying has advantages such as reduction of shrinkage and total cyanogenic toxicity of cassava, but carotenoids significantly reduced.

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