Walnut Structure and Its Influence on Hydration Characteristics

Chang Chen[1,2], Chandrasekar Venkitasamy[1,2], Weipeng Zhang[3], Ragab Khir[1,4], Zhongli Pan[1,2]

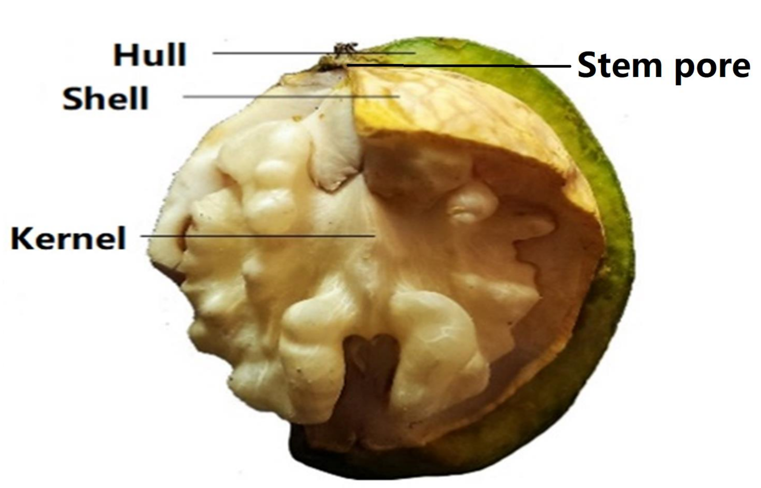
[1] Department of Biological & Agricultural Engineering, University of California, Davis, One Shields Avenue, Davis, CA 95616, USA
[2] Healthy Processed Foods Research Unit, USDA-ARS-WRRC, 800 Buchanan St., Albany, CA 94710, USA
[3] College of Engineering, China Agricultural University, Beijing,100083, P. R. China
[4] Department of Agricultural Engineering, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt

Abstract

Walnuts are washed in water before drying in the industry. The objective of this study was to investigate the influence of walnut structure (stem pore) on the hydration characteristics. The stem pore of walnuts was sealed with epoxy and compared with non-sealed walnuts (control). The moisture transport pathways into the walnuts were investigated using fluorescence tracer method, and the hydration kinetics of walnuts under different soaking temperatures was determined for the first time and fitted using Peleg model. The results indicated that the stem pore played an important role in the moisture absorption during the soaking process. Up to 3.5% moisture content (MC) was absorbed in sealed walnuts after 5 min soaking compared to 5.7% MC for non-sealed walnuts. Both the presence of stem pore and temperature had significant ($p<0.05$) effect on the hydration kinetics. The findings are helpful to understand the moisture transfer characteristics and to predict the moisture absorption into walnuts during washing process.

Background

- Walnuts are usually hulled, washed in water and then dried with hot air (HA) as a continuous post-harvest process in the industry.
- The hydration kinetics of walnuts has not been investigated in the past. It is helpful for the understanding of the water transport mechanism and prediction of moisture absorption during walnut soaking process.
- A small pore formed naturally at the stem location of walnut shell is observed, which may affect the moisture transfer characteristics during the walnut washing/soaking process.



Anatomy of walnut

Industrial walnut hulling and washing process

Objectives

- Investigate the water transfer pathway into the walnuts during soaking process
- Study the influence of the presence of the stem pore on the hydration characteristics of walnuts
- Determine the hydration kinetics of walnut at different soaking temperatures

Materials and Methods

Sample preparation:

The stem pore of walnuts was sealed with water-resistant epoxy glue in the experimental group and the non-sealed was considered as the control.

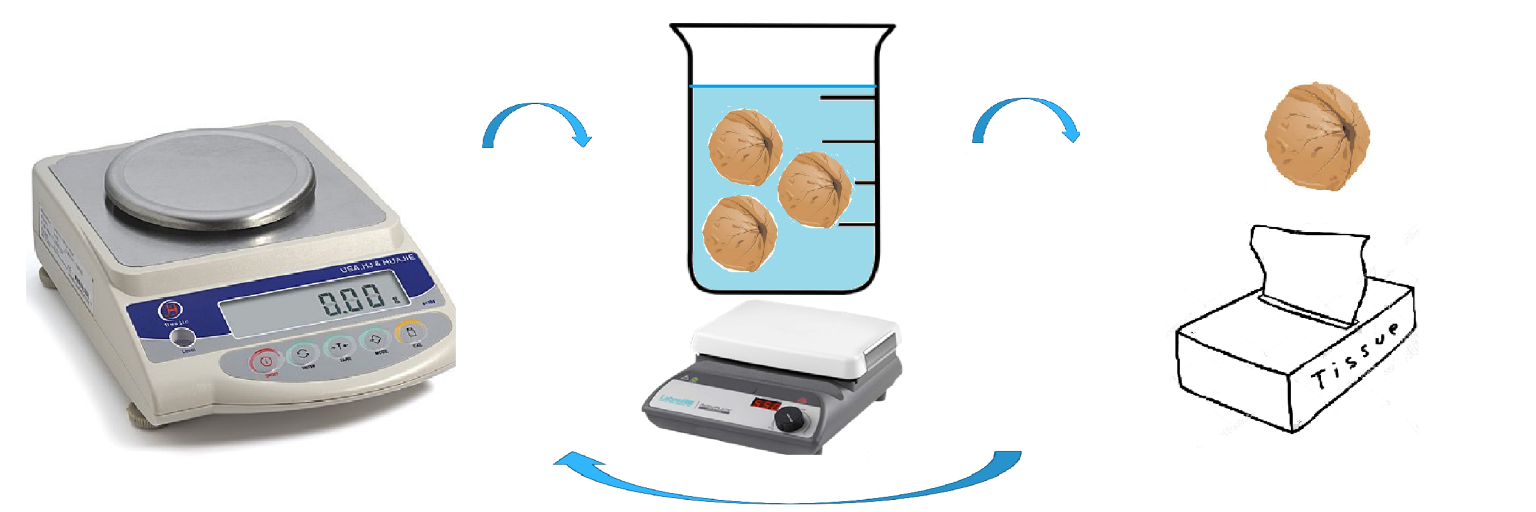
Materials and Methods (continued)

Water transport pathway:

- Walnuts were soaked in water with pink fluorescence dye for different time periods.
- Walnuts were cut through across the suture direction after soaking.
- Fluorescence pattern was observed under blacklight and visible light.

Non-sealed walnuts   Sealed walnuts

Hydration test:



Weighing with electronic balance

Soaking at different water temepratures (15, 25 and 35°C)

Sampling at different soaking times and cleaning with paper tissue

Hydration kinetics:

- The hydration curves were fitted with the Peleg model

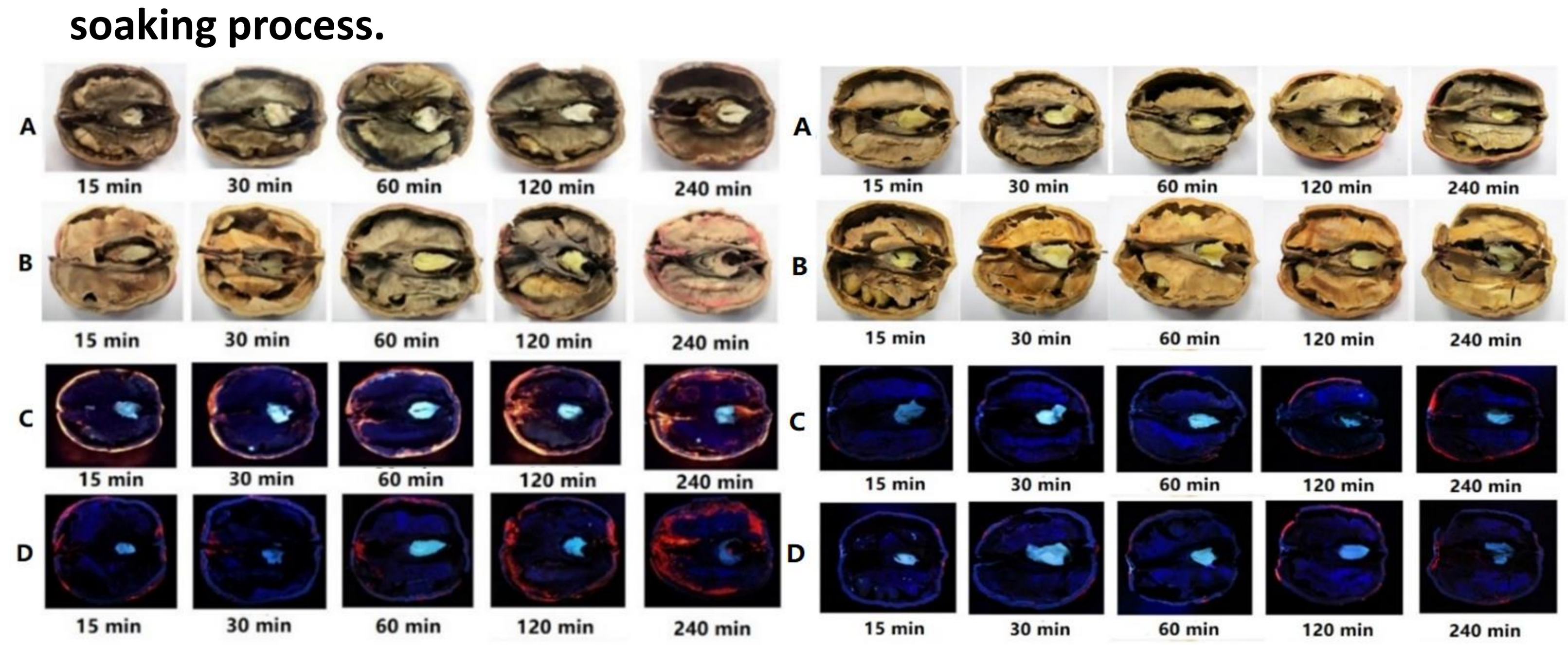
$$M(t) = M_0 + \frac{t}{K_i + K_2 * t}$$

M(t) is the MC (%) of walnut at time t; M_0 is the initial moisture content (IMC); K_1 is the Peleg rate (min/% MC); and K_2 is the Peleg capacity constant (1/% MC)

Results and Discussions

Fluorescence tracing:

- Fluorescence pattern started to appear at the stem pore location after 30 min soaking and extend gradually with soaking time.
- Water mainly transferred through the inner membrane of walnuts during the soaking process.



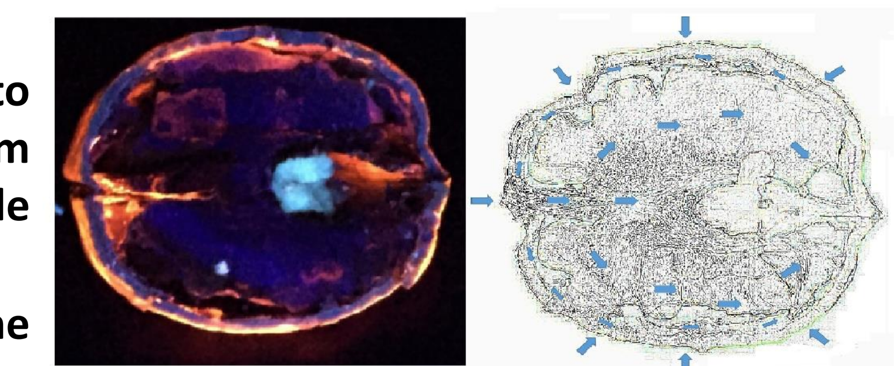
Water permeation in the non-sealed (Left) and sealed (right) walnuts under visible light: (a) dry walnuts; (b) wet walnuts; and blacklight: (c) dry walnuts and (d) wet walnuts

Contact: Dr. Zhongli Pan, Phone: 530-752-4367
E-mail: Zhongli.pan@ars.usda.gov; or zlpan@ucdavis.edu
Website: http://research.engineering.ucdavis.edu/panlab/

Results and Discussion (continued)

water transfer pathway:

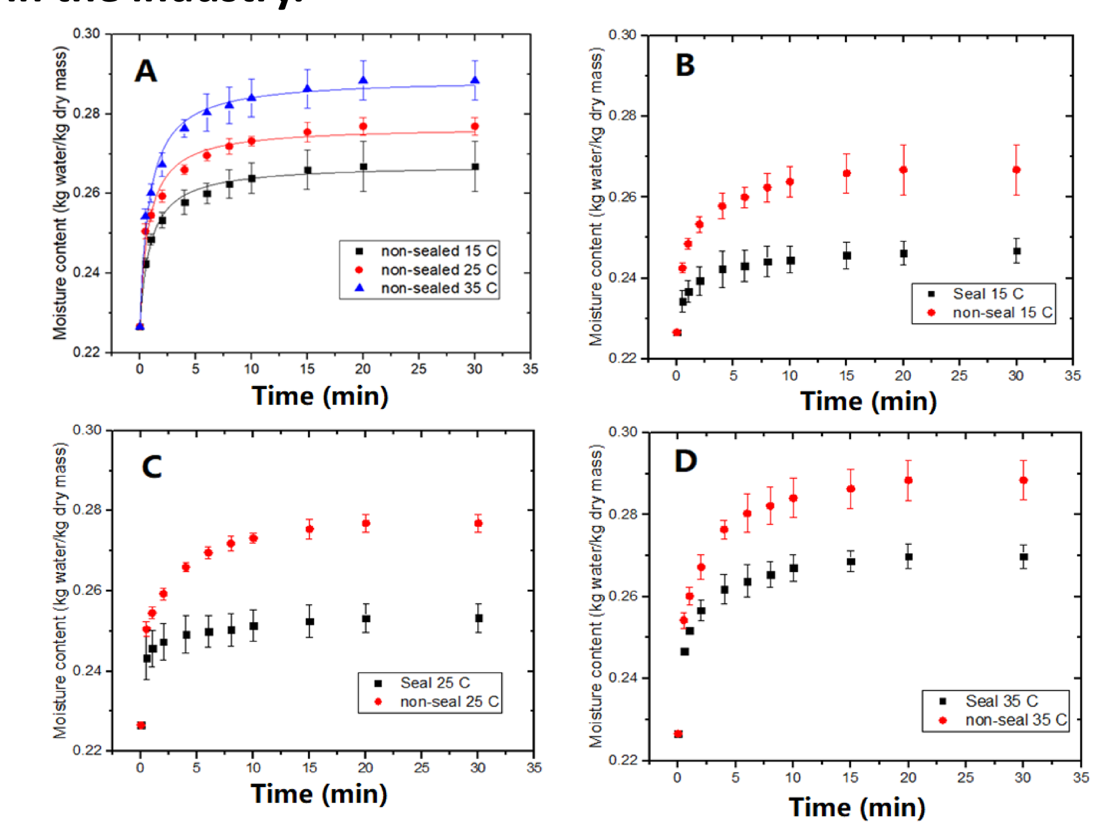
- Water mainly transferred into the walnut through the stem pore and extended alongside the dissepiments.
- Water permeation across the shell was slower compared to through the stem pore.



Water permeation path-way in the walnut depicted by the blue arrows

Hydration curves:

- Both water absorption capability and rate increased with temperature.
- Presence of the stem pore had significant ($p<0.05$) influence on the hydration kinetics of walnuts.
- Walnuts may absorb 3.3-4.1% MC (d.b.) during the 2-5 min soaking process in the industry.



Hydration curves of walnuts: (a) non-sealed at 15, 25 and 35°C and comparison between sealed and non-sealed at (b) 15°C; (c) 25°C; and (d) 35°C

Hydration kinetics parameters:

Pore	IMC (%)	Temperature (°C)	K_1 (min $\%^{-1}$)	K_2 ($\%^{-1}$)	R^2
Non-sealed	22.7 ± 7.8	15	0.230 ± 0.019 a	0.245 ± 0.004 a	0.99
		25	0.157 ± 0.019 b	0.199 ± 0.005 ab	0.98
		35	0.135 ± 0.012 bc	0.161 ± 0.003 b	0.99
Sealed	22.7 ± 7.8	15	0.507 ± 0.041 A	0.497 ± 0.009 A	0.99
		25	0.166 ± 0.019 B	0.389 ± 0.007 AB	0.98
		35	0.128 ± 0.015 BC	0.231 ± 0.004 B	0.98

Conclusion

The hydration characteristics of walnuts during the soaking/washing process were significantly ($p<0.05$) influenced by the presence of the stem pore and temperature. The results provide important information for predicting the effect of washing process on the MC absorption of walnuts before drying.

Acknowledgments

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