Physical Property Changes in Soaked and Activated Almonds

Clay Swackhamer[1], Yamile Mennah-Govela[1], and Gail M. Bornhorst[1,2]
[1]Department of Biological and Agricultural Engineering, [2]Department of Food Science and Technology,
University of California, Davis

Introduction

Soaking of almonds and others nuts prior to consumption has been common practice for several centuries. Activation of almonds and other nuts has recently become popular in the US. Activation typically involves an initial step of soaking in water followed by low temperature drying. Physical properties of foods, such as fracture properties and moisture content impact sensory perception as well as breakdown and nutrient release after consumption. It has been demonstrated that fracture properties of almonds were correlated with their metabolizable energy content1; almonds fracturing into fewer, larger particles after uniaxial compression had a lower metabolizable energy content, hypothesized to be due to lesser release of nutrients from the almond matrix. The objective of this study was to quantify physical properties of almonds after soaking and activation.

Materials and Methods

Almond Treatments:

Soaking Temp	Soaking Time (h)					Activation
	8	10	12	16	24	
21°C	✓	✓	✓	✓	✓	-
4°C	✓	✓	✓	✓	✓	-
21°C	-	-	✓	✓	✓	16 hr at 50 °C
4°C	-	-	✓	✓	✓	16 hr at 50 °C


Soaked almonds: 21°C for 12h


Soaked almonds: 4°C for 12h

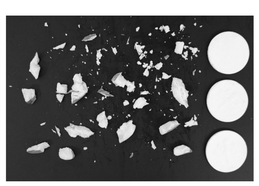
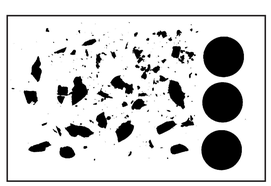
Measurements:

- **Moisture content** was measured gravimetrically (5h at 95°C and 100 mmHg): AOAC Official Method 925.40
- **Hardness and fracture force** were measured using a TA-XT2 Texture Analyzer with the following parameters:

Test	Test Speed	Strain/ Distance	Probe	Value Quantified	Result
Uniaxial compression*	30 mm/s	71% strain	45 mm cylinder probe	Peak (max) force measured during compression	Hardness (N)
3 point bending	1 mm/s	12 mm	Knife blade 3 mm thick rounded end		Fracture Force (N)

*Compressed almonds were used for particle size analysis

Particle Size using Image Analysis:

- Fractured almonds spread over a dark field to minimize overlap.
- Image read into MATLAB and converted to 8-bit grayscale
- Automated thresholding algothim applied to improve contrast
- Image converted to binary using Otsu's method, then inverted
- Pixels/mm2 calibration performed by averaging area of three dimes, identified using Hough transform
- Objects enumerated, those less than 0.132 mm2 discarded

Results

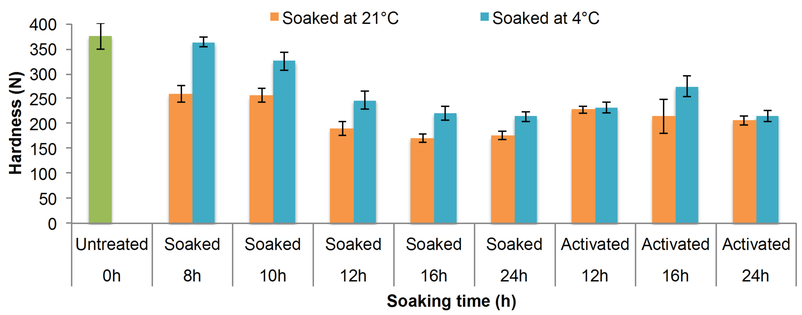


Figure 1. Hardness (N) of soaked almonds at 21°C and at 4°C for different soaking times. Results represent the average (n=10) ± standard error of the mean (SEM). Hardness was significantly influenced by soaking time, temperature and drying ($p<0.001$).

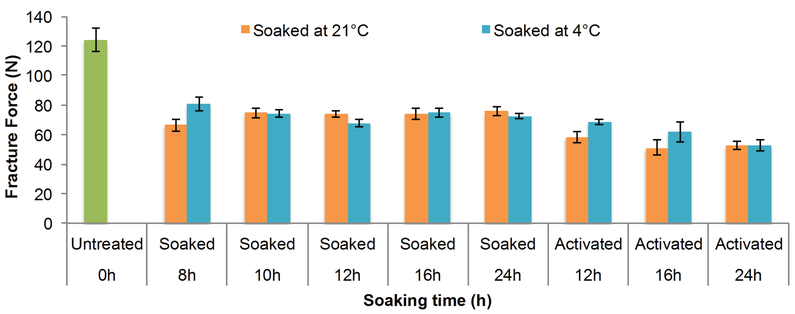


Figure 2. Fracture force (N) of almonds soaked 21°C and at 4°C during different times and after drying at 50°C for 16h. Results represent the average (n=10) ± SEM. Fracture force was significantly influenced by soaking time and drying ($p<0.05$).

	Moisture Content (wet basis)	
Soaking time	21°C	4°C
0h	3 ± 0 %	
8h	30 ± 2 %	25 ± 3 %
10h	34 ± 2 %	25 ± 3 %
12h	34 ± 1 %	23 ± 2 %
16h	35 ± 1 %	24 ± 0 %
24h	38 ± 1 %	29 ± 1 %
12h + drying 50°C	9 ± 1 %	6 ± 0 %
16h + drying 50°C	8 ± 0 %	6 ± 0 %
24h + drying 50°C	9 ± 1 %	6 ± 0 %

Table 1. Moisture content (wet basis) of each treatment. Values represent the average (n=3) ± SEM. Moisture content was significantly influenced by soaking temperature and drying ($p<0.0001$).

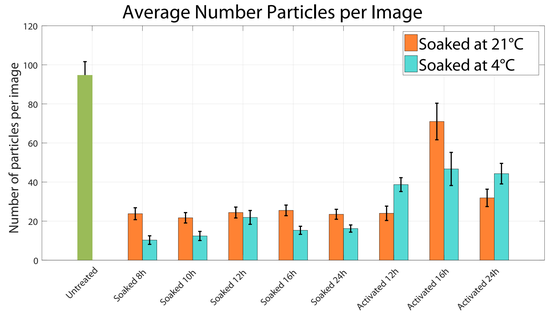
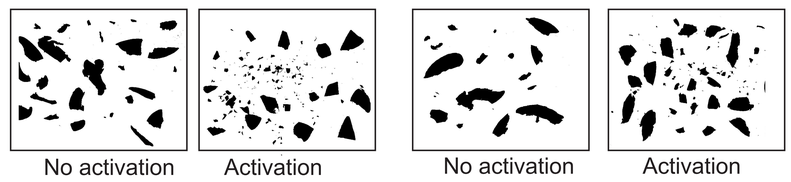


Figure 3. Number of particles per image for all treatments. Results represent the average (n=10) ± SEM. Number of particles per image was significantly influenced by soaking time and drying ($p<0.01$).



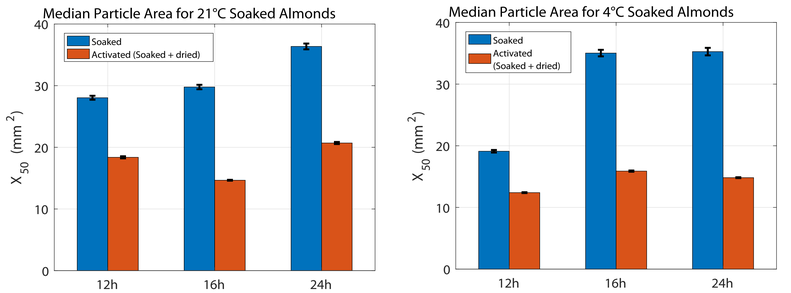


Figure 4. Median particle area (X50) was calculated by fitting the cumulative distribution of particle areas to the Rosin-Rammler model (R2 min = 0.99).

Conclusions

- **Hardness** decrease was greater in almonds soaked at 21°C, likely due to increased moisture uptake during soaking
- **Fracture force** was higher in soaked almonds than activated almonds
- **Moisture content** was higher in almonds soaked at room termperature than in almonds soaked at 4°C
- **Soaked almonds fractured into fewer, larger particles** than activated almonds
- Untreated almonds (control) differed from treated almonds in all measurements
- Soaking and activation modify almond physical properties as a function of soaking time and soaking temperature, warranting furthur investigation

Reference

Gebauer, Sarah et. al. "Food Processing and Structure Impact the Metabolizable Energy of Almonds." Food Funct. 7.10 (2016): 4231-238.

gbornhorst@ucdavis.edu