processes MDPI

Supplementary Material

Effect of Pouch Size on Sterilization of Ready-To-Eat (RTE) Bracken Ferns: Numerical Simulation and Texture Evaluation

Mesh convergence study

Table S1. Effect of mesh resolution on the average temperature and the cold point temperature of BF pouch.

Sample	Mesh refinements	Number of elements	Average temperature at t = 10 min (°C)	Cold point temperature at t = 10 min (°C)	Maximum element size (mm)	Minimum element size (mm)
100 g	Coarser	732	88.15	34.61	35.60	7.49
	Coarse	1646	87.97	33.54	28.10	5.24
	Normal	5434	88.03	34.89	18.70	3.37
	Fine	8731	87.82	35.14	15.00	1.87
	Finer	19172	87.73	35.43	10.30	0.75
	Extra fine	63871	87.75	35.48	6.55	0.28
	Extremely fine	291425	87.76	35.51	3.74	0.04
150 g	Coarser	1337	77.99	20.5	35.70	7.51
	Coarse	2329	77.95	19.25	28.20	5.26
	Normal	5027	78.06	21.52	18.80	3.38
	Fine	11670	78.01	21.28	15.00	1.88
	Finer	20468	77.94	21.63	10.30	0.75
	Extra fine	69733	77.92	21.6	6.57	0.28
	Extremely fine	282467	77.93	21.56	3.76	0.04
200 g	Coarser	1494	58.98	9.77	35.40	7.46
	Coarse	2631	56.99	13.76	28.00	5.22
	Normal	5399	55.78	14.91	18.60	3.36
	Fine	9960	56.28	15.18	14.90	1.86
	Finer	25597	55.95	15.47	10.30	0.75
	Extra fine	75568	55.54	15.61	6.52	0.28
	Extremely fine	333149	55.39	15.69	3.73	0.04

Mesh independence: Grid convergence index approach

Mesh independence was calculated by the grid convergence index (GCI) method (Celik et al., 2008). First, the representative mesh size *h* for three-dimensional calculations was defined as:

$$h = \left[\frac{1}{N}\sum_{i=1}^{N}(\Delta V_i)\right]^{1/3} \quad \text{(S1)}$$

where ΔV_i is the volume of the *i*th cell, and *N* is the total number of cells in the computational domain.

The mesh configurations "Finer", "Extra fine", and "Extremely fine" in Table S1 were selected as three significantly different sets of grids to examine the adequacy of the mesh resolution. The grid refinement factor *r* was calculated as follows:

$$r_{21} = \frac{h_{Extra\ fine}}{h_{Extremely\ fine}},\ r_{32} = \frac{h_{Finer}}{h_{Extra\ fine}} \quad \text{(S2)}$$

Then, the apparent order p of the method was calculated:

$$p = \frac{1}{\ln(r_{21})} |\ln|\varepsilon_{32}/\varepsilon_{21}| + q(p)| \qquad \text{(S3)}$$

$$\varepsilon_{21} = \phi_2 - \phi_1,\ \varepsilon_{32} = \phi_3 - \phi_2 \qquad \text{(S4)}$$

where ϕ_1, ϕ_2, and ϕ_3 are the solution (average temperature and cold point temperature in this study) on the "Extremely fine", "Extra fine", and "Finer" mesh configuration, respectively. $q(p) = 0$ when r is constant.

Finally, GCI was determined using the following equations:

$$\mathrm{GCI}_{21} = \frac{1.25 e_a^{21}}{r_{21}^{p} - 1},\ \mathrm{GCI}_{32} = \frac{1.25 e_a^{32}}{r_{32}^{p} - 1} \qquad \text{(S5)}$$

$$e_a^{21} = \left|\frac{\phi_1 - \phi_2}{\phi_1}\right|,\ e_a^{32} = \left|\frac{\phi_2 - \phi_3}{\phi_2}\right| \qquad \text{(S6)}$$

where e_a is approximate relative error.

The values defined by the Equations S1-S6 are listed in Table S2.

Table S2. Calculations of values using Equations S1-S6.

	100 g		150 g		200 g	
	Average temperature at t = 10 min (°C)	Cold point temperature at t = 10 min (°C)	Average temperature at t = 10 min (°C)	Cold point temperature at t = 10 min (°C)	Average temperature at t = 10 min (°C)	Cold point temperature at t = 10 min (°C)
r_{21}, r_{32}	1.66, 1.49		1.59, 1.50		1.43, 1.64	
P	1.37	1.01	1.49	0.62	2.04	1.13
e_a^{21}, e_a^{32} (%)	0.02, 0.01	0.14, 0.09	0.03, 0.01	0.14, 0.19	0.73, 0.27	0.90, 0.51
GCI_{21}, GCI_{32} (%)	0.03, 0.02	0.44, 0.32	0.03, 0.02	0.52, 0.81	0.53, 0.31	1.51, 1.27

Time-step dependence analysis

Table S3. Effect of time-step on the average temperature and the cold point temperature of BF pouch.

Sample	Time-step (min)	Average temperature at t = 10 min (°C)	Cold point temperature at t = 10 min (°C)
100 g	2	88.20	35.81
	1	87.91	35.56
	0.5	87.75	35.46
	0.1	87.75	35.46
	0.01	87.75	35.46
150 g	2	78.38	21.92
	1	78.11	21.69
	0.5	77.92	21.6
	0.1	77.92	21.6
	0.01	77.92	21.6
200 g	2	55.79	15.71
	1	55.61	15.63
	0.5	55.54	15.61
	0.1	55.54	15.61
	0.01	55.54	15.61