REFERENCES

Association of Official Analytical Chemists (AOAC). 1995. ***Official method of analysis*** 16th ed. Washington, DC.: Association of Official Analytical Chemists.

Beleia, A., Miller, R.A., and Horsney, R.C. 1996. Starch gelatinization in sugar solutions. ***Starch/Starke*** 48:259-262.

Bircan, C. and Barringer, S.A. 1998. Salt-starch interactions as evidenced by viscosity and dielectric property measurements. ***J. Food Sci.*** 63(6):983-986.

Callister, W.D. 1997. ***Material Science and Engineering: An Introduction***. 4th ed. New York: John Wiley & Sons.

Chaiwanichsiri, S., Ohnishi, S., Suzuki, T., Takai, R., and Miyawaki, O. 2001. Measurement of electrical conductivity, differential scanning calorimetry and viscosity of starch and flour suspensions during gelatinisation process. ***J. Sci Food Agric.*** 81: 1586-1591.

Chaiwanichsiri, S., Miyawaki, O., and Suzuki, T. 2004. Electrical conductivity, differential scanning calorimetry and viscosity of potato starch suspensions during gelatinisation: Effect of Additives, ***Proceedings of International Conference on Engineering and Food***. 7-12 March 2004, Montpellier, France.

Chinachoti, P., Kim-Shin, M., Mari, F., and Lo, L. 1991a. Gelatinization of wheat starch in the presence of sucrose and sodium chloride: correlation between gelatinization temperature and water mobility as determined by oxygen-17 Nuclear Magnetic Resonance. ***Cereal Chem***. 68(3): 244-248.

Chinachoti, P., White, V.A., Lo, L., and Stengle, T.R. 1991b. Application of high-resolution carbon-13, oxygen-17, and sodium-23 Nuclear Magnetic Resonance to study the influences of water, sucrose, and sodium chloride on starch gelatinization. ***Cereal Chem***. 68(3): 238-244.

de Alwis, A.A.P., and Fryer, P.J. 1990. A finite element analysis of heat generation and transfer during ohmic heating of food. ***Chem. Eng. Sci***. 45(6):1547-1559.

de Alwis, A.A.P., and Fryer, P.J. 1992. Operability of the ohmic heating process: Electrical conductivity effect ***J. Food Eng***. 15(1) : 21-48.

de Alwis, A.A.P., Halden, K., and Fryer, P.J. 1989. Shape and conductivity effects in the ohmic heating of food. ***Chem. Eng. Res. Des***. 67: 159-168.

Fryer, P.J. , De Alwis, A.A.P., Koury, E., Stapley, A.G.F., and Zhang, L. 1993. Ohmic heating of solid-liquid foods; heat generation and convection effects. ***J. Food Eng***. 18(1): 101-125.

Fu, W.R., and Hsieh,C.-C. 1999. Simulation and verification of 2-dimensional ohmic heating in static system. ***J. Food Sci.*** 64(6):946-949.

Halden, K., deAlwis, A.A.P., and Fryer, P.J. 1990. Changes in the electrical conductivity of foods during ohmic heating. ***Int. J. Food Sci Technol***. 25: 9-25.

Imai, T., Uemura, K., Ishida, N., Yoshizaki, S., and Noguchi, A. 1995. Ohmic heating of Japanese white radish *Rhaphanus sativus. L.* ***Int. J. Food Sci. Technol***. 30: 461-472.

Kanchanakitsakul, S. 1999. Effective electrical conductivity of low-acid foods during ohmic heating. MS thesis, Chulalongkorn University, Bangkok, Thailand.

Khalaf, W.G., and Sastry, S.K. 1996. Effect of fluid viscosity on the ohmic heating rate of solid-liquid mixtures. ***J. Food Eng***. 27(1): 145-158.

Kim, H.J., Choi,Y.M., Yang, T.C.S., Taub, I.A., Tempest, P., Skudder, P., Tucker, G., and Parrott, D.L. 1996. Validation of ohmic heating for quality enhancement of food products. ***Food Technol.*** 50(5): 253-261.

Lima, M., Heskitt, B., and Sastry, S.K. 1999. The effect of frequency and waveform on the electrical conductivity-temperature profiles of turnip tissue. ***J. Food Proc. Eng.*** 22(1): 41-54.

Lima, M., Heskitt, B., and Sastry, S.K. 2001. Diffusion of beet dye during electrical and conventional heating at steady-state temperature. ***J. Food Proc. Eng.*** 24(5): 331-340.

Lima, M., and Sastry, S.K. 1999. The effect of ohmic heating frequency on hot-air drying rate and juice yield. ***J. Food Eng***. 41:115-119.

Lisinska, G., and Leszezynski, W. 1989. ***Potato Science and Technology*** London, England: Elsevier Applied Science Publisher Ltd.

Marcotte, M., Ramaswamy, H.S., and Piette, J.P.G. 1998. Ohmic heating behavior of hydrocolloid solutions. ***Food Res. Intl.*** 31(6-7): 493-502.

Marcotte, M., Trigui, M., and Ramaswamy, H.S. 2000. Effect of salt and citric acid on electrical conductivities and ohmic heating of viscous liquids. ***J. Food Proc. Preserv.*** 24: 389-406.

Palaniappan, S., and Sastry, S.K. 1991a. Electrical conductivity of selected solid foods during ohmic heating. ***J. Food Proc. Eng.*** 14(4): 221-236.

Palaniappan, S., and Sastry, S.K. 1991b. Electrical conductivity of selected juices: Influence of temperature, solid content, applied voltage and particle size. ***J. Food Proc. Eng.*** 14(4): 247-260.

Palaniappan, S., and Sastry, S.K. 1991c. Modelling of Electrical conductivity of selected liquid-particle mixtures. ***Trans I. Chem. Eng.*** 69 Part C: 167-173.

Park, S.J., Kim, D., Uemura , K., and Noguchi, A. 1995. Influence of frequency on ohmic heating of fish-protein gel. ***J. Japanese Soc. Food Sci. Tech.*** 42(8): 569-574.

Parrott, D.L. 1992. Use of ohmic heating for aseptic processing of food particulate. ***Food Technol.*** 46(12):68-72.

Plaichoom, P. 2002. Pasteurization of pineapple-drinking yoghurt by ohmic heating. MS thesis, Chulalongkorn University, Bangkok, Thailand.

Rice, P., Selman, J.D., and Abdul-Rezzak, R.K. 1988. Effect of temperature on thermal properties of 'Record' potatoes. ***Int. J. Food Sci Technol.*** 23: 281-286.

Sastry, S.K. 1992. A model for heating of liquid-particle mixtures in a continuous flow ohmic heater. ***J. Food Proc. Eng.*** 15(4): 263-278.

Sastry, S.K. 1993. Electroconductive (Ohmic) heating for continuous sterilization for solid-liquid food mixtures. Ohio : The Ohio State University Research Foundation.

Sastry, S.K., and Barach, J.T. 2000. Ohmic and inductive heating. ***J. Food Sci.*** 65(4) supplement. pp.42-46.

Sastry, S.K., and Li, Q. 1996. Modelling the ohmic heating of foods. ***Food Technol.*** 50 (5): 246-248.

Sastry, S.K., and Palaniappan, S. 1992a. Mathematical modeling and experimental studies on ohmic heating of a liquid-particle mixtures in a static heater. ***J. Food Proc. Eng.*** 15(4): 241-261.

Sastry, S.K., and Palaniappan, S. 1992b. Influence of particle orientation on the effective electrical resistance and ohmic heating rate of a liquid-particle mixture. ***J. Food Proc. Eng.*** 15(4): 213-227.

Sastry, S.K., and Palaniappan, S. 1992c. Ohmic heating of liquid-particle mixtures. ***Food Technol.*** 46(12): 64-67.

Schereier, P., Reid, D., and Fryer, P. 1993. Enhanced Diffusion during the electrical heating of foods. ***Int. J. Food Sci. Tech***. 28: 249-260.

Skudder, P., and Biss, C. 1987. Aseptic processing of food products using ohmic heating. ***Chem. Eng.*** 433: 26-28.

Sudhakar, V., Singhal, R.S., and Kukarni, P.R. 1995a. Effect of sucrose on starch-hydrocolloid interactions. ***Food Chemistry*** 52: 281-284.

Sudhakar, V., Singhal, R.S., and Kukarni, P.R. 1995b. Studies on starch-hydrocolloid interactions: Effect of salts. ***Food Chemistry*** 53: 405-408.

Suwansakornkul, P., Kongpan, O., and Oka, H. 1999. "Improvement of the gel forming ability of Threadfin Bream surimi." ***Fish Technology : research and inspection*** vol III, 25-31.

Sweat, V.E. 1986. Thermal properties of foods. In M.A. Rao and S.S.H. Rizvi (ed.), ***Engineering Properties of Foods***. pp. 49-87. New York: Marcel Dekker.

Toledo, R.T. 1991. ***Fundamentals of Food Process Engineering*** 2nd ed. NewYork: Van Nostrand Reinhold.

Wang, W., and Sastry, S.K. 1993. Salt diffusion into vegetable tissue as a pretreatment for ohmic heating: electrical conductivity profiles and vacuum infusion studies. ***J. Food Eng.*** 20(4): 299-309.

Wang, W., and Sastry, S.K. 1997a. Starch gelatinization in ohmic heating. ***J. Food Eng.*** 34(3): 225-245.

Wang, W., and Sastry, S.K. 1997b. Change in electrical conductivity of selected vegetables during multiple thermal treatments. ***J. Food Proc. Eng.*** 20: 499-516.

Wang, W., and Sastry, S.K. 2002. Effects of moderate electrothermal treatments on juice yield from cellular tissue. ***Innov. Food Sci. Emerg. Tech.*** 3: 371-377.

Wu, H., Kolbe, E., Flugstad, B., Park, J.W., and Yongsawatdigul, J. 1998. Electrical properties of fish mince during multi-frequency ohmic heating. ***J. Food Sci.*** 63(6): 1028-1032.

Yongsawatdigul, J., Park, J.W., and Kolbe, E. 1995. Electrical conductivity of Pacific Whiting Surimi Paste during ohmic heating. ***J. Food Sci.*** 60(5): 922-925.

Zhang, L., and Fryer, P.J. 1993. Models for the electrical heating of solid-liquid food mixtures. ***Chem. Eng. Sci.*** 48: 633-643.

Zhang, L., and Fryer, P.J. 1995. A comparison of alternative formulations for the prediction of electrical heating rates of solid-liquid food materials. ***J. Food Proc. Eng.*** 18(1): 85-97.

Zhong, T., and Lima, M. 2003. The effect of ohmic heating on vacuum drying rate of sweet potato tissue. ***Biores. Tech.*** 27: 215-220.

Zoltai, P., and Swearingen, P. 1996. Product development considerations for ohmic processing. ***Food Technol.*** 50(5): 263-266.

Zumdahl, S. 1997. ***Chemistry***. 4th ed. New York: Houghton Miffin Company.

APPENDICES

APPENDIX A

STATISTICAL DATA OF FACTORS AFFCTING ELECTRICAL CONDUCTIVITY OF SOLID FOODS

I. Effect of voltage

Table A1 Analysis of variance of the effect of voltage on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of blanched and soaked potato

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	1.732E-02	2	8.660E-03	2.851	.110
	Within Groups	2.733E-02	9	3.037E-03		
	Total	4.465E-02	11			
Temperature Coefficient	Between Groups	1.307E-06	2	6.533E-07	.746	.501
	Within Groups	7.880E-06	9	8.756E-07		
	Total	9.187E-06	11			

Table A2 Analysis of variance of the effect of voltage on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of blanched and soaked white radish

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	7.646E-03	2	3.823E-03	3.685	.057
	Within Groups	1.245E-02	12	1.037E-03		
	Total	2.009E-02	14			
Temperature Coefficient	Between Groups	5.333E-07	2	2.667E-07	1.471	.268
	Within Groups	2.175E-06	12	1.812E-07		
	Total	2.708E-06	14			

Table A3 Analysis of variance of the effect of voltage on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of cooked pork

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	1.049E-02	2	5.243E-03	2.416	.123
	Within Groups	3.255E-02	15	2.170E-03		
	Total	4.303E-02	17			
Temperature Coefficient	Between Groups	3.600E-09	2	1.800E-09	.005	.995
	Within Groups	5.595E-06	15	3.730E-07		
	Total	5.599E-06	17			

Table A4 Analysis of variance of the effect of voltage on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of cooked white radish

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	.144	2	7.202E-02	4.100	.054
	Within Groups	.158	9	1.757E-02		
	Total	.302	11			
Temperature Coefficient	Between Groups	1.544E-05	2	7.720E-06	2.718	.119
	Within Groups	2.556E-05	9	2.840E-06		
	Total	4.100E-05	11			

II. Effect of Frequency

Table A5 Analysis of variance of the effect of frequency on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of blanched and soaked potato

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	2.846E-03	2	1.423E-03	.386	.690
	Within Groups	3.315E-02	9	3.683E-03		
	Total	3.599E-02	11			
Temperature Coefficient	Between Groups	1.167E-08	2	5.833E-09	.039	.962
	Within Groups	1.337E-06	9	1.486E-07		
	Total	1.349E-06	11			

Table A6 Analysis of variance of the effect of frequency on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of blanched and soaked white radish

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	4.228E-06	2	2.114E-06	.006	.994
	Within Groups	4.066E-03	12	3.388E-04		
	Total	4.070E-03	14			
Temperature Coefficient	Between Groups	2.093E-07	2	1.047E-07	.136	.874
	Within Groups	9.208E-06	12	7.673E-07		
	Total	9.417E-06	14			

Table A7 Analysis of variance of the effect of frequency on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of cooked pork

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	5.743E-04	2	2.872E-04	.199	.822
	Within Groups	2.166E-02	15	1.444E-03		
	Total	2.223E-02	17			
Temperature Coefficient	Between Groups	1.111E-09	2	5.556E-10	.032	.969
	Within Groups	2.633E-07	15	1.756E-08		
	Total	2.644E-07	17			

Table A8 Analysis of variance of the effect of frequency on electrical conductivity at 25° C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of cooked surimi

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	3.442E-03	2	1.721E-03	.399	.682
	Within Groups	3.884E-02	9	4.316E-03		
	Total	4.228E-02	11			
Temperature Coefficient	Between Groups	4.867E-07	2	2.433E-07	.063	.939
	Within Groups	3.474E-05	9	3.860E-06		
	Total	3.523E-05	11			

APPENDIX B

STATISTICAL DATA OF FACTORS AFFECTING ELECTRICAL CONDUCTIVITY OF LIQUID FOODS

Table B1 Analysis of variance of the effect of voltage on electrical conductivity at 25°C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of 1% salt solution

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	6.322E-04	2	3.161E-04	1.468	.303
	Within Groups	1.292E-03	6	2.153E-04		
	Total	1.924E-03	8			
Temperature coefficient	Between Groups	2.780E-06	2	1.390E-06	3.534	.097
	Within Groups	2.360E-06	6	3.933E-07		
	Total	5.140E-06	8			

Table B2 Analysis of variance of the effect of frequency on electrical conductivity at 25°C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of 1% salt solution

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	1.923E-04	2	9.616E-05	3.123	.118
	Within Groups	1.847E-04	6	3.079E-05		
	Total	3.770E-04	8			
Temperature coefficient	Between Groups	5.400E-07	2	2.700E-07	2.793	.139
	Within Groups	5.800E-07	6	9.667E-08		
	Total	1.120E-06	8			

Table B3 Analysis of variance of the effect of salt concentration on electrical conductivity at 25°C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of liquid

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	4.920	2	2.460	9634.439	.000
	Within Groups	1.532E-03	6	2.553E-04		
	Total	4.921	8			
Temperature coefficient	Between Groups	2.010E-02	2	1.005E-02	9.608	.013
	Within Groups	6.275E-03	6	1.046E-03		
	Total	2.637E-02	8			

Table B4 Analysis of variance of the effect of starch concentration on electrical conductivity at 25°C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of 1% salt solution

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	.208	4	5.193E-02	491.452	.000
	Within Groups	1.057E-03	10	1.057E-04		
	Total	.209	14			
Temperature coefficient	Between Groups	8.486E-05	4	2.122E-05	23.417	.000
	Within Groups	9.060E-06	10	9.060E-07		
	Total	9.392E-05	14			

Table B5 Analysis of variance of the effect of sugar concentration on electrical conductivity at 25°C (σ_{25}) and temperature coefficient ($m\sigma_{25}$) of 1% salt solution

		Sum of Squares	df	Mean Square	F	Sig.
Electrical conductivity at 25 deg.C	Between Groups	.619	4	.155	536.289	.000
	Within Groups	2.883E-03	10	2.883E-04		
	Total	.621	14			
Temperature coefficient	Between Groups	7.486E-05	4	1.872E-05	95.164	.000
	Within Groups	1.967E-06	10	1.967E-07		
	Total	7.683E-05	14			

APPENDIX C

PHYSICAL AND THERMAL PROPERTIES OF STUDIED MATERIALS

Table C1 Density and estimated* specific heat of the materials

Materials	Moisture content (%)	Specific heat (J / kg °C)	Density (kg /m^3)
Liquid**	93.37	3963	1033
Potato	83.69	3639	1091
White radish	95.17	4023	962
Surimi	79.28	3491	1015

* from equation 2.9
** 0.75% salt-2 % sugar-4% starch liquid

APPENDIX D

COMPARISON BETWEEN THE CALCULATED EFFECTIVE ELECTRICAL CONDUCTIVITY FROM THE CIRCUIT-ANALOGY CONCEPT AND THE EXPERIMENTAL DATA

Table D1 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of unsalted potato in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.*	%dif.**	model	expt.	%dif.	model	expt.	%dif.
25	1.1457	1.0745	6.63	0.9569	1.0064	-4.92	0.7791	0.852	-8.56
30	1.2392	1.168	6.10	1.0419	1.0979	-5.10	0.8556	0.9285	-7.85
35	1.3327	1.2615	5.64	1.1269	1.1894	-5.25	0.9321	1.005	-7.25
40	1.4262	1.355	5.25	1.2119	1.2809	-5.39	1.0086	1.0815	-6.74
45	1.5197	1.4485	4.92	1.2969	1.3724	-5.50	1.0851	1.158	-6.30
50	1.6132	1.542	4.62	1.3819	1.4639	-5.60	1.1616	1.2345	-5.91
55	1.7067	1.6355	4.35	1.4669	1.5554	-5.69	1.2381	1.311	-5.56
60	1.8002	1.729	4.12	1.5519	1.6469	-5.77	1.3146	1.3875	-5.25
65	1.8937	1.8225	3.91	1.6369	1.7384	-5.84	1.3911	1.464	-4.98
70	1.9872	1.916	3.72	1.7219	1.8299	-5.90	1.4676	1.5405	-4.73
75	2.0807	2.0095	3.54	1.8069	1.9214	-5.96	1.5441	1.617	-4.51
80	2.1742	2.103	3.39	1.8919	2.0129	-6.01	1.6206	1.6935	-4.30
85	2.2677	2.1965	3.24	1.9769	2.1044	-6.06	1.6971	1.77	-4.12
90	2.3612	2.29	3.11	2.0619	2.1959	-6.10	1.7736	1.8465	-3.95
95	2.4547	2.3835	2.99	2.1469	2.2874	-6.14	1.8501	1.923	-3.79
100	2.5482	2.477	2.87	2.2319	2.3789	-6.18	1.9266	1.9995	-3.65
105	2.6417	2.5705	2.77	2.3169	2.4704	-6.21	2.0031	2.076	-3.51
110	2.7352	2.664	2.67	2.4019	2.5619	-6.25	2.0796	2.1525	-3.39
115	2.8287	2.7575	2.58	2.4869	2.6534	-6.27	2.1561	2.229	-3.27
120	2.9222	2.851	2.50	2.5719	2.7449	-6.30	2.2326	2.3055	-3.16
125	3.0157	2.9445	2.42	2.6569	2.8364	-6.33	2.3091	2.382	-3.06

* experiment ** difference between model and experiment

Table D2 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of salted potato in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.1365	1.104	2.94	1.119	1.064	5.17	0.8625	0.9435	-8.59
30	1.237	1.207	2.49	1.216	1.16	4.83	0.956	1.033	-7.45
35	1.3375	1.31	2.10	1.313	1.256	4.54	1.0495	1.1225	-6.50
40	1.438	1.413	1.77	1.41	1.352	4.29	1.143	1.212	-5.69
45	1.5385	1.516	1.48	1.507	1.448	4.07	1.2365	1.3015	-4.99
50	1.639	1.619	1.24	1.604	1.544	3.89	1.33	1.391	-4.39
55	1.7395	1.722	1.02	1.701	1.64	3.72	1.4235	1.4805	-3.85
60	1.84	1.825	0.82	1.798	1.736	3.57	1.517	1.57	-3.38
65	1.9405	1.928	0.65	1.895	1.832	3.44	1.6105	1.6595	-2.95
70	2.041	2.031	0.49	1.992	1.928	3.32	1.704	1.749	-2.57
75	2.1415	2.134	0.35	2.089	2.024	3.21	1.7975	1.8385	-2.23
80	2.242	2.237	0.22	2.186	2.12	3.11	1.891	1.928	-1.92
85	2.3425	2.34	0.11	2.283	2.216	3.02	1.9845	2.0175	-1.64
90	2.443	2.443	0.00	2.38	2.312	2.94	2.078	2.107	-1.38
95	2.5435	2.546	-0.10	2.477	2.408	2.87	2.1715	2.1965	-1.14
100	2.644	2.649	-0.19	2.574	2.504	2.80	2.265	2.286	-0.92
105	2.7445	2.752	-0.27	2.671	2.6	2.73	2.3585	2.3755	-0.72
110	2.845	2.855	-0.35	2.768	2.696	2.67	2.452	2.465	-0.53
115	2.9455	2.958	-0.42	2.865	2.792	2.61	2.5455	2.5545	-0.35
120	3.046	3.061	-0.49	2.962	2.888	2.56	2.639	2.644	-0.19
125	3.1465	3.164	-0.55	3.059	2.984	2.51	2.7325	2.7335	-0.04

Table D3 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of unsalted white radish in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.1112	1.0659	4.25	0.8855	0.9551	-7.29	0.6775	0.757	-10.50
30	1.2032	1.1539	4.27	0.967	1.0371	-6.76	0.749	0.8285	-9.60
35	1.2952	1.2419	4.29	1.0485	1.1191	-6.31	0.8205	0.9	-8.83
40	1.3872	1.3299	4.31	1.13	1.2011	-5.92	0.892	0.9715	-8.18
45	1.4792	1.4179	4.32	1.2115	1.2831	-5.58	0.9635	1.043	-7.62
50	1.5712	1.5059	4.34	1.293	1.3651	-5.28	1.035	1.1145	-7.13
55	1.6632	1.5939	4.35	1.3745	1.4471	-5.02	1.1065	1.186	-6.70
60	1.7552	1.6819	4.36	1.456	1.5291	-4.78	1.178	1.2575	-6.32
65	1.8472	1.7699	4.37	1.5375	1.6111	-4.57	1.2495	1.329	-5.98
70	1.9392	1.8579	4.38	1.619	1.6931	-4.38	1.321	1.4005	-5.68
75	2.0312	1.9459	4.38	1.7005	1.7751	-4.20	1.3925	1.472	-5.40
80	2.1232	2.0339	4.39	1.782	1.8571	-4.04	1.464	1.5435	-5.15
85	2.2152	2.1219	4.40	1.8635	1.9391	-3.90	1.5355	1.615	-4.92
90	2.3072	2.2099	4.40	1.945	2.0211	-3.77	1.607	1.6865	-4.71
95	2.3992	2.2979	4.41	2.0265	2.1031	-3.64	1.6785	1.758	-4.52
100	2.4912	2.3859	4.41	2.108	2.1851	-3.53	1.75	1.8295	-4.35
105	2.5832	2.4739	4.42	2.1895	2.2671	-3.42	1.8215	1.901	-4.18
110	2.6752	2.5619	4.42	2.271	2.3491	-3.32	1.893	1.9725	-4.03
115	2.7672	2.6499	4.43	2.3525	2.4311	-3.23	1.9645	2.044	-3.89
120	2.8592	2.7379	4.43	2.434	2.5131	-3.15	2.036	2.1155	-3.76
125	2.9512	2.8259	4.43	2.5155	2.5951	-3.07	2.1075	2.187	-3.64

Table D4 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of salted white radish in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.2364	1.2111	2.09	1.136	1.1523	-1.41	1.0392	1.0714	-3.01
30	1.3369	1.3146	1.70	1.2345	1.2568	-1.77	1.1357	1.1644	-2.46
35	1.4374	1.4181	1.36	1.333	1.3613	-2.08	1.2322	1.2574	-2.00
40	1.5379	1.5216	1.07	1.4315	1.4658	-2.34	1.3287	1.3504	-1.61
45	1.6384	1.6251	0.82	1.53	1.5703	-2.57	1.4252	1.4434	-1.26
50	1.7389	1.7286	0.60	1.6285	1.6748	-2.76	1.5217	1.5364	-0.96
55	1.8394	1.8321	0.40	1.727	1.7793	-2.94	1.6182	1.6294	-0.69
60	1.9399	1.9356	0.22	1.8255	1.8838	-3.09	1.7147	1.7224	-0.45
65	2.0404	2.0391	0.06	1.924	1.9883	-3.23	1.8112	1.8154	-0.23
70	2.1409	2.1426	-0.08	2.0225	2.0928	-3.36	1.9077	1.9084	-0.04
75	2.2414	2.2461	-0.21	2.121	2.1973	-3.47	2.0042	2.0014	0.14
80	2.3419	2.3496	-0.33	2.2195	2.3018	-3.58	2.1007	2.0944	0.30
85	2.4424	2.4531	-0.44	2.318	2.4063	-3.67	2.1972	2.1874	0.45
90	2.5429	2.5566	-0.54	2.4165	2.5108	-3.76	2.2937	2.2804	0.58
95	2.6434	2.6601	-0.63	2.515	2.6153	-3.84	2.3902	2.3734	0.71
100	2.7439	2.7636	-0.71	2.6135	2.7198	-3.91	2.4867	2.4664	0.82
105	2.8444	2.8671	-0.79	2.712	2.8243	-3.98	2.5832	2.5594	0.93
110	2.9449	2.9706	-0.87	2.8105	2.9288	-4.04	2.6797	2.6524	1.03
115	3.0454	3.0741	-0.93	2.909	3.0333	-4.10	2.7762	2.7454	1.12
120	3.1459	3.1776	-1.00	3.0075	3.1378	-4.15	2.8727	2.8384	1.21
125	3.2464	3.2811	-1.06	3.106	3.2423	-4.20	2.9692	2.9314	1.29

Table D5 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of surimi in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.3108	1.2733	2.95	1.2848	1.2864	-0.12	1.2585	1.2991	-3.13
30	1.4193	1.3808	2.79	1.3993	1.3994	-0.01	1.379	1.4156	-2.59
35	1.5278	1.4883	2.65	1.5138	1.5124	0.09	1.4995	1.5321	-2.13
40	1.6363	1.5958	2.54	1.6283	1.6254	0.18	1.62	1.6486	-1.73
45	1.7448	1.7033	2.44	1.7428	1.7384	0.25	1.7405	1.7651	-1.39
50	1.8533	1.8108	2.35	1.8573	1.8514	0.32	1.861	1.8816	-1.09
55	1.9618	1.9183	2.27	1.9718	1.9644	0.38	1.9815	1.9981	-0.83
60	2.0703	2.0258	2.20	2.0863	2.0774	0.43	2.102	2.1146	-0.60
65	2.1788	2.1333	2.13	2.2008	2.1904	0.47	2.2225	2.2311	-0.39
70	2.2873	2.2408	2.08	2.3153	2.3034	0.52	2.343	2.3476	-0.20
75	2.3958	2.3483	2.02	2.4298	2.4164	0.55	2.4635	2.4641	-0.02
80	2.5043	2.4558	1.97	2.5443	2.5294	0.59	2.584	2.5806	0.13
85	2.6128	2.5633	1.93	2.6588	2.6424	0.62	2.7045	2.6971	0.27
90	2.7213	2.6708	1.89	2.7733	2.7554	0.65	2.825	2.8136	0.41
95	2.8298	2.7783	1.85	2.8878	2.8684	0.68	2.9455	2.9301	0.53
100	2.9383	2.8858	1.82	3.0023	2.9814	0.70	3.066	3.0466	0.64
105	3.0468	2.9933	1.79	3.1168	3.0944	0.72	3.1865	3.1631	0.74
110	3.1553	3.1008	1.76	3.2313	3.2074	0.75	3.307	3.2796	0.84
115	3.2638	3.2083	1.73	3.3458	3.3204	0.76	3.4275	3.3961	0.92
120	3.3723	3.3158	1.70	3.4603	3.4334	0.78	3.548	3.5126	1.01
125	3.4808	3.4233	1.68	3.5748	3.5464	0.80	3.6685	3.6291	1.09

Table D6 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of unsalted potato and white radish in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.1306	1.1279	0.24	0.9216	1.0395	-11.34	0.7295	0.8089	-9.82
30	1.2271	1.2274	-0.02	1.0116	1.124	-10.00	0.8135	0.8954	-9.15
35	1.3236	1.3269	-0.25	1.1016	1.2085	-8.85	0.8975	0.9819	-8.60
40	1.4201	1.4264	-0.44	1.1916	1.293	-7.84	0.9815	1.0684	-8.13
45	1.5166	1.5259	-0.61	1.2816	1.3775	-6.96	1.0655	1.1549	-7.74
50	1.6131	1.6254	-0.76	1.3716	1.462	-6.18	1.1495	1.2414	-7.40
55	1.7096	1.7249	-0.89	1.4616	1.5465	-5.49	1.2335	1.3279	-7.11
60	1.8061	1.8244	-1.00	1.5516	1.631	-4.87	1.3175	1.4144	-6.85
65	1.9026	1.9239	-1.11	1.6416	1.7155	-4.31	1.4015	1.5009	-6.62
70	1.9991	2.0234	-1.20	1.7316	1.8	-3.80	1.4855	1.5874	-6.42
75	2.0956	2.1229	-1.29	1.8216	1.8845	-3.34	1.5695	1.6739	-6.24
80	2.1921	2.2224	-1.36	1.9116	1.969	-2.92	1.6535	1.7604	-6.07
85	2.2886	2.3219	-1.43	2.0016	2.0535	-2.53	1.7375	1.8469	-5.92
90	2.3851	2.4214	-1.50	2.0916	2.138	-2.17	1.8215	1.9334	-5.79
95	2.4816	2.5209	-1.56	2.1816	2.2225	-1.84	1.9055	2.0199	-5.66
100	2.5781	2.6204	-1.61	2.2716	2.307	-1.53	1.9895	2.1064	-5.55
105	2.6746	2.7199	-1.67	2.3616	2.3915	-1.25	2.0735	2.1929	-5.44
110	2.7711	2.8194	-1.71	2.4516	2.476	-0.99	2.1575	2.2794	-5.35
115	2.8676	2.9189	-1.76	2.5416	2.5605	-0.74	2.2415	2.3659	-5.26
120	2.9641	3.0184	-1.80	2.6316	2.645	-0.51	2.3255	2.4524	-5.17
125	3.0606	3.1179	-1.84	2.7216	2.7295	-0.29	2.4095	2.5389	-5.10

Table D7 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of unsalted potato and surimi in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.2439	1.1544	7.75	1.151	1.1042	4.24	1.0391	1.0612	-2.08
30	1.3489	1.2614	6.94	1.2585	1.2117	3.86	1.1496	1.1712	-1.84
35	1.4539	1.3684	6.25	1.366	1.3192	3.55	1.2601	1.2812	-1.65
40	1.5589	1.4754	5.66	1.4735	1.4267	3.28	1.3706	1.3912	-1.48
45	1.6639	1.5824	5.15	1.581	1.5342	3.05	1.4811	1.5012	-1.34
50	1.7689	1.6894	4.71	1.6885	1.6417	2.85	1.5916	1.6112	-1.22
55	1.8739	1.7964	4.31	1.796	1.7492	2.68	1.7021	1.7212	-1.11
60	1.9789	1.9034	3.97	1.9035	1.8567	2.52	1.8126	1.8312	-1.02
65	2.0839	2.0104	3.66	2.011	1.9642	2.38	1.9231	1.9412	-0.93
70	2.1889	2.1174	3.38	2.1185	2.0717	2.26	2.0336	2.0512	-0.86
75	2.2939	2.2244	3.12	2.226	2.1792	2.15	2.1441	2.1612	-0.79
80	2.3989	2.3314	2.90	2.3335	2.2867	2.05	2.2546	2.2712	-0.73
85	2.5039	2.4384	2.69	2.441	2.3942	1.95	2.3651	2.3812	-0.68
90	2.6089	2.5454	2.49	2.5485	2.5017	1.87	2.4756	2.4912	-0.63
95	2.7139	2.6524	2.32	2.656	2.6092	1.79	2.5861	2.6012	-0.58
100	2.8189	2.7594	2.16	2.7635	2.7167	1.72	2.6966	2.7112	-0.54
105	2.9239	2.8664	2.01	2.871	2.8242	1.66	2.8071	2.8212	-0.50
110	3.0289	2.9734	1.87	2.9785	2.9317	1.60	2.9176	2.9312	-0.46
115	3.1339	3.0804	1.74	3.086	3.0392	1.54	3.0281	3.0412	-0.43
120	3.2389	3.1874	1.62	3.1935	3.1467	1.49	3.1386	3.1512	-0.40
125	3.3439	3.2944	1.50	3.301	3.2542	1.44	3.2491	3.2612	-0.37

Table D8 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of unsalted white radish and surimi in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.2375	1.2247	1.05	1.1382	1.0859	4.82	1.04	1.088	-4.41
30	1.3425	1.3307	0.89	1.2457	1.1919	4.51	1.1495	1.19	-3.40
35	1.4475	1.4367	0.75	1.3532	1.2979	4.26	1.259	1.292	-2.55
40	1.5525	1.5427	0.64	1.4607	1.4039	4.05	1.3685	1.394	-1.83
45	1.6575	1.6487	0.53	1.5682	1.5099	3.86	1.478	1.496	-1.20
50	1.7625	1.7547	0.44	1.6757	1.6159	3.70	1.5875	1.598	-0.66
55	1.8675	1.8607	0.37	1.7832	1.7219	3.56	1.697	1.7	-0.18
60	1.9725	1.9667	0.29	1.8907	1.8279	3.44	1.8065	1.802	0.25
65	2.0775	2.0727	0.23	1.9982	1.9339	3.32	1.916	1.904	0.63
70	2.1825	2.1787	0.17	2.1057	2.0399	3.23	2.0255	2.006	0.97
75	2.2875	2.2847	0.12	2.2132	2.1459	3.14	2.135	2.108	1.28
80	2.3925	2.3907	0.08	2.3207	2.2519	3.06	2.2445	2.21	1.56
85	2.4975	2.4967	0.03	2.4282	2.3579	2.98	2.354	2.312	1.82
90	2.6025	2.6027	-0.01	2.5357	2.4639	2.91	2.4635	2.414	2.05
95	2.7075	2.7087	-0.04	2.6432	2.5699	2.85	2.573	2.516	2.27
100	2.8125	2.8147	-0.08	2.7507	2.6759	2.80	2.6825	2.618	2.46
105	2.9175	2.9207	-0.11	2.8582	2.7819	2.74	2.792	2.72	2.65
110	3.0225	3.0267	-0.14	2.9657	2.8879	2.69	2.9015	2.822	2.82
115	3.1275	3.1327	-0.17	3.0732	2.9939	2.65	3.011	2.924	2.98
120	3.2325	3.2387	-0.19	3.1807	3.0999	2.61	3.1205	3.026	3.12
125	3.3375	3.3447	-0.22	3.2882	3.2059	2.57	3.23	3.128	3.26

Table D9 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of salted potato and white radish in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.2454	1.1665	6.76	1.154	1.107	4.25	1.0656	1.097	-2.86
30	1.3494	1.275	5.84	1.2595	1.209	4.18	1.1726	1.193	-1.71
35	1.4534	1.3835	5.05	1.365	1.311	4.12	1.2796	1.289	-0.73
40	1.5574	1.492	4.38	1.4705	1.413	4.07	1.3866	1.385	0.12
45	1.6614	1.6005	3.81	1.576	1.515	4.03	1.4936	1.481	0.85
50	1.7654	1.709	3.30	1.6815	1.617	3.99	1.6006	1.577	1.50
55	1.8694	1.8175	2.86	1.787	1.719	3.96	1.7076	1.673	2.07
60	1.9734	1.926	2.46	1.8925	1.821	3.93	1.8146	1.769	2.58
65	2.0774	2.0345	2.11	1.998	1.923	3.90	1.9216	1.865	3.03
70	2.1814	2.143	1.79	2.1035	2.025	3.88	2.0286	1.961	3.45
75	2.2854	2.2515	1.51	2.209	2.127	3.86	2.1356	2.057	3.82
80	2.3894	2.36	1.25	2.3145	2.229	3.84	2.2426	2.153	4.16
85	2.4934	2.4685	1.01	2.42	2.331	3.82	2.3496	2.249	4.47
90	2.5974	2.577	0.79	2.5255	2.433	3.80	2.4566	2.345	4.76
95	2.7014	2.6855	0.59	2.631	2.535	3.79	2.5636	2.441	5.02
100	2.8054	2.794	0.41	2.7365	2.637	3.77	2.6706	2.537	5.27
105	2.9094	2.9025	0.24	2.842	2.739	3.76	2.7776	2.633	5.49
110	3.0134	3.011	0.08	2.9475	2.841	3.75	2.8846	2.729	5.70
115	3.1174	3.1195	-0.07	3.053	2.943	3.74	2.9916	2.825	5.90
120	3.2214	3.228	-0.20	3.1585	3.045	3.73	3.0986	2.921	6.08
125	3.3254	3.3365	-0.33	3.264	3.147	3.72	3.2056	3.017	6.25

Table D10 Comparison between the calculated effective electrical conductivity from the circuit-analogy concept and the experimental data of salted potato and surimi in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.278	1.2495	-2.28	1.222	1.265	3.52	1.1645	1.155	-0.82
30	1.386	1.358	-2.06	1.336	1.379	3.22	1.284	1.283	-0.08
35	1.494	1.4665	-1.88	1.45	1.493	2.97	1.4035	1.411	0.53
40	1.602	1.575	-1.71	1.564	1.607	2.75	1.523	1.539	1.04
45	1.71	1.6835	-1.57	1.678	1.721	2.56	1.6425	1.667	1.47
50	1.818	1.792	-1.45	1.792	1.835	2.40	1.762	1.795	1.84
55	1.926	1.9005	-1.34	1.906	1.949	2.26	1.8815	1.923	2.16
60	2.034	2.009	-1.24	2.02	2.063	2.13	2.001	2.051	2.44
65	2.142	2.1175	-1.16	2.134	2.177	2.01	2.1205	2.179	2.68
70	2.25	2.226	-1.08	2.248	2.291	1.91	2.24	2.307	2.90
75	2.358	2.3345	-1.01	2.362	2.405	1.82	2.3595	2.435	3.10
80	2.466	2.443	-0.94	2.476	2.519	1.74	2.479	2.563	3.28
85	2.574	2.5515	-0.88	2.59	2.633	1.66	2.5985	2.691	3.44
90	2.682	2.66	-0.83	2.704	2.747	1.59	2.718	2.819	3.58
95	2.79	2.7685	-0.78	2.818	2.861	1.53	2.8375	2.947	3.72
100	2.898	2.877	-0.73	2.932	2.975	1.47	2.957	3.075	3.84
105	3.006	2.9855	-0.69	3.046	3.089	1.41	3.0765	3.203	3.95
110	3.114	3.094	-0.65	3.16	3.203	1.36	3.196	3.331	4.05
115	3.222	3.2025	-0.61	3.274	3.317	1.31	3.3155	3.459	4.15
120	3.33	3.311	-0.57	3.388	3.431	1.27	3.435	3.587	4.24
125	3.438	3.4195	-0.54	3.502	3.545	1.23	3.5545	3.715	4.32

Table D11 Comparison between the calculated effective electrical conductivity from the circuit analogy-concept and the experimental data of salted white radish and surimi in liquid

Temp. (°C)	Effective electrical conductivity (S/m) at volume fraction								
	0.2			0.4			0.6		
	model	expt.	%dif.	model	expt.	%dif.	model	expt.	%dif.
25	1.309	1.284	-1.95	1.28	1.272	-0.63	1.2525	1.1465	-9.25
30	1.418	1.395	-1.65	1.395	1.388	-0.50	1.374	1.266	-8.53
35	1.527	1.506	-1.39	1.51	1.504	-0.40	1.4955	1.3855	-7.94
40	1.636	1.617	-1.18	1.625	1.62	-0.31	1.617	1.505	-7.44
45	1.745	1.728	-0.98	1.74	1.736	-0.23	1.7385	1.6245	-7.02
50	1.854	1.839	-0.82	1.855	1.852	-0.16	1.86	1.744	-6.65
55	1.963	1.95	-0.67	1.97	1.968	-0.10	1.9815	1.8635	-6.33
60	2.072	2.061	-0.53	2.085	2.084	-0.05	2.103	1.983	-6.05
65	2.181	2.172	-0.41	2.2	2.2	0.00	2.2245	2.1025	-5.80
70	2.29	2.283	-0.31	2.315	2.316	0.04	2.346	2.222	-5.58
75	2.399	2.394	-0.21	2.43	2.432	0.08	2.4675	2.3415	-5.38
80	2.508	2.505	-0.12	2.545	2.548	0.12	2.589	2.461	-5.20
85	2.617	2.616	-0.04	2.66	2.664	0.15	2.7105	2.5805	-5.04
90	2.726	2.727	0.04	2.775	2.78	0.18	2.832	2.7	-4.89
95	2.835	2.838	0.11	2.89	2.896	0.21	2.9535	2.8195	-4.75
100	2.944	2.949	0.17	3.005	3.012	0.23	3.075	2.939	-4.63
105	3.053	3.06	0.23	3.12	3.128	0.26	3.1965	3.0585	-4.51
110	3.162	3.171	0.28	3.235	3.244	0.28	3.318	3.178	-4.41
115	3.271	3.282	0.34	3.35	3.36	0.30	3.4395	3.2975	-4.31
120	3.38	3.393	0.38	3.465	3.476	0.32	3.561	3.417	-4.21
125	3.489	3.504	0.43	3.58	3.592	0.34	3.6825	3.5365	-4.13

APPENDIX E

COMPARISON BETWEEN TEMPERATURE FROM MODEL AND FROM EXPERIMENTAL DATA

Table E1 Comparison between the temperature from the model and the experimental data of unsalted potato in 0.75% salt-2% sugar-4% starch liquid

Time	Temper-ature of	Temperature of each component at volume fraction (°C)											
(s)	pure liquid	0.2				0.4				0.6			
	(°C)	liquid	solid	model	%dif.[a]	liquid	solid	model	%dif.[a]	liquid	solid	model	%dif.[b]
0	25.15	25.19	24.44	25.00	2.28	24.40	24.19	25.00	3.34	24.36	24.65	25.00	2.63
5	27.07	28.28	26.01	28.25	8.62	25.65	25.50	27.72	8.74	25.06	25.28	27.23	8.66
10	30.15	31.76	28.86	31.67	9.71	26.59	27.62	30.58	10.71	27.62	28.54	29.55	6.98
15	34.58	35.50	31.39	35.27	12.35	30.48	30.55	33.57	9.89	29.78	31.91	31.97	7.36
20	39.01	38.83	34.87	39.06	12.01	34.10	33.96	36.71	8.11	32.71	34.73	34.50	5.47
25	42.89	43.26	38.54	43.05	11.73	37.07	36.81	40.00	8.65	34.52	36.58	37.14	7.59
30	48.13	47.69	41.72	47.26	13.27	41.32	40.51	43.45	7.24	36.04	38.35	39.90	10.69
35	53.81	51.76	45.97	51.69	12.44	45.79	44.43	47.06	5.92	38.63	40.21	42.77	10.72
40	59.93	56.81	50.48	56.35	11.64	49.52	48.61	50.85	4.62	41.60	43.23	45.78	10.05
45	65.13	62.20	55.46	61.26	10.46	54.43	52.23	54.83	4.96	44.53	46.46	48.91	9.84
50	72.02	67.99	59.60	66.43	11.47	59.56	56.92	58.99	3.64	47.41	50.78	52.18	10.06
55	79.52	72.93	65.13	71.87	10.36	64.87	61.94	63.36	2.29	50.59	54.25	55.59	9.90
60	85.82	79.27	71.14	77.61	9.10	69.30	66.19	67.94	2.64	54.10	58.13	59.15	9.34
65	94.21	85.97	76.15	83.64	9.84	75.20	71.87	72.74	1.21	58.86	63.11	62.87	6.81
70	103.37	91.76	83.00	90.00	8.43	81.32	77.91	77.77	-0.18	63.77	68.35	66.75	4.67
75	113.33	99.41	90.40	96.70	6.96	86.45	84.51	83.05	-1.72	68.06	73.85	70.80	4.03
80	121.80	107.07	97.91	103.74	5.96	93.11	90.04	88.58	-1.62	73.70	78.68	75.03	1.80
85	130.26	113.88	104.65	111.17	6.23	100.04	97.33	94.38	-3.03	79.71	84.87	79.44	-0.33
90		123.08	113.74	118.98	4.61	107.33	105.24	100.46	-4.54	86.01	91.39	84.04	-2.28
95		132.82	123.52	127.21	2.99	112.71	111.39	106.83	-4.09	91.17	96.67	88.85	-2.55
100		142.57	133.30	135.88	1.94	120.48	120.33	113.52	-5.66	98.02	103.77	93.87	-4.24
105						128.65	130.00	120.52	-7.29	105.35	111.06	99.10	-5.93
110										111.10	118.02	104.56	-5.88
115										119.16	124.43	110.27	-7.46
120										127.66	132.89	116.22	-8.96

[a] difference between model and solid [b] difference between model and liquid

Table E2 Comparison between the temperature from the model and the experimental data of salted potato in 0.75% salt-2% sugar-4% starch liquid

Time (s)	Temperature of pure liquid (°C)	Temperature of each component at volume fraction (°C)											
		0.2				0.4				0.6			
		liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [b]
0	25.15	25.07	24.81	25.00	0.77	24.92	24.80	25.00	0.79	24.81	24.98	25.00	0.77
5	27.07	26.19	26.87	28.23	5.05	27.57	26.64	27.84	4.51	26.41	27.95	27.47	4.03
10	30.15	29.45	28.84	31.64	9.71	30.25	28.92	30.64	6.65	28.61	30.44	30.08	5.15
15	34.58	32.31	31.44	35.25	12.11	32.27	30.57	34.01	11.25	31.76	33.77	32.83	3.37
20	39.01	36.26	35.10	39.06	11.27	36.15	33.21	37.35	12.48	34.91	37.36	35.72	2.34
25	42.89	40.73	39.02	43.09	10.42	39.45	37.54	40.88	8.89	38.21	40.37	38.77	1.49
30	48.13	45.31	43.50	47.35	8.85	43.74	40.17	44.60	11.04	41.25	44.32	41.99	1.80
35	53.81	49.27	47.97	51.85	8.09	48.35	45.28	48.53	7.18	44.98	48.54	45.37	0.87
40	59.93	54.76	52.99	56.62	6.84	52.16	49.35	52.68	6.75	49.12	53.00	48.94	-0.36
45	65.13	60.51	57.09	61.65	7.98	57.29	54.67	57.06	4.36	52.75	56.78	52.70	-0.08
50	72.02	65.46	62.59	66.97	7.00	62.82	59.36	61.68	3.90	57.22	61.72	56.66	-0.97
55	79.52	71.94	68.52	72.59	5.94	67.47	62.39	66.55	6.67	61.03	67.07	60.84	-0.31
60	85.82	78.76	74.97	78.54	4.76	73.59	69.63	71.70	2.97	65.06	71.54	65.24	0.28
65	94.21	86.08	80.46	84.82	5.42	80.22	74.07	77.13	4.13	69.50	77.44	69.87	0.53
70	103.37	91.94	88.01	91.47	3.93	87.22	80.59	82.86	2.82	75.15	83.70	74.75	-0.53
75	113.33	99.34	96.77	98.49	1.77	93.19	87.47	88.90	1.64	81.22	89.05	79.90	-1.63
80	121.80	107.18	103.59	105.91	2.25	101.03	93.30	95.29	2.13	88.55	96.08	85.32	-3.65
85	130.26	113.81	112.74	113.76	0.90	109.38	103.03	102.03	-0.97	96.67	103.74	91.03	-5.83
90		122.53	119.45	122.05	2.18	116.34	109.30	109.14	-0.15	102.23	111.91	97.05	-5.07
95		131.47	127.66	130.82	2.48	125.79	118.17	116.64	-1.29	106.92	118.72	103.39	-3.31
100						135.71	126.21	124.56	-1.31	111.98	127.18	110.07	-1.70
105										118.79	132.67	117.11	-1.41
110										126.63	140.99	124.53	-1.66

[a] difference between model and solid [b] difference between model and liquid

Table E3 Comparison between the temperature from the model and the experimental data of unsalted white radish in 0.75% salt-2% sugar-4% starch liquid

Time (s)	Temperature of pure liquid (°C)	Temperature of each component at volume fraction (°C)											
		0.2				0.4				0.6			
		liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [b]
0	25.15	24.63	24.88	25.00	0.47	24.51	24.76	25.00	0.96	25.15	24.50	25.00	-0.61
5	27.07	28.16	27.46	28.17	2.58	27.47	26.96	27.54	2.17	26.78	26.04	26.96	0.70
10	30.15	32.60	31.21	31.51	0.96	30.44	29.30	30.21	3.08	29.27	28.83	29.01	-0.88
15	34.58	36.23	34.36	35.02	1.92	32.93	31.25	33.00	5.60	31.50	31.65	31.14	-1.14
20	39.01	39.41	37.03	38.72	4.54	36.12	34.03	35.91	5.54	34.29	33.99	33.36	-2.70
25	42.89	43.66	40.59	42.61	4.98	39.63	36.96	38.97	5.44	37.18	37.11	35.67	-4.05
30	48.13	48.10	44.36	46.70	5.28	43.22	40.04	42.17	5.33	39.63	40.29	38.08	-3.92
35	53.81	52.78	47.58	51.01	7.21	46.26	42.82	45.52	6.30	42.89	43.77	40.59	-5.38
40	59.93	56.96	51.91	55.55	7.02	50.48	46.37	49.02	5.71	44.23	45.99	43.20	-2.32
45	65.13	62.45	56.56	60.32	6.65	54.58	50.18	52.69	5.00	46.30	47.56	45.92	-0.83
50	72.02	68.28	63.58	65.35	2.79	58.24	53.41	56.53	5.86	50.00	51.26	48.75	-2.50
55	79.52	73.30	67.75	70.63	4.26	62.97	57.58	60.56	5.16	53.00	54.14	51.70	-2.47
60	85.82	79.89	73.39	76.20	3.83	68.06	62.09	64.77	4.31	56.85	57.11	54.77	-3.66
65	94.21	87.14	80.44	82.06	2.02	73.26	65.90	69.17	4.97	61.03	61.39	57.97	-5.01
70	103.37	94.87	86.56	88.22	1.92	77.80	71.03	73.79	3.89	64.47	65.71	61.30	-4.92
75	113.33	101.43	92.52	94.71	2.37	83.81	76.48	78.62	2.79	68.79	69.34	64.77	-5.85
80	121.80	110.22	101.89	101.54	-0.33	90.15	82.38	83.67	1.57	73.48	73.92	68.38	-6.94
85	130.26	118.90	109.36	108.73	-0.57	95.57	88.21	88.96	0.86	77.18	78.79	72.15	-6.52
90		126.59	118.06	116.30	-1.49	102.53	97.29	94.50	-2.86	82.05	84.18	76.07	-7.29
95		132.96	126.89	124.26	-2.07	110.11	103.04	100.30	-2.66	87.11	88.72	80.15	-7.99
100						117.66	107.40	106.38	-0.95	92.42	94.25	84.40	-8.67
105						124.10	115.50	112.73	-2.39	96.85	100.22	88.83	-8.28
110						132.71	123.66	119.38	-3.46	102.56	104.80	93.44	-8.89
115										108.61	111.39	98.24	-9.54
120										113.59	118.10	103.25	-9.11
125										120.04	124.80	108.46	-9.65
130										126.70	129.32	113.88	-10.12

[a] difference between model and solid [b] difference between model and liquid

Table E4 Comparison between the temperature from the model and the experimental data of salted white radish in 0.75% salt-2% sugar-4% starch liquid

Time (s)	Temperature of pure liquid (°C)	Temperature of each component at volume fraction (°C)											
		0.2				0.4				0.6			
		liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [b]	liquid	solid	model	%dif. [b]
0	25.15	25.30	24.92	25.00	0.33	25.06	24.55	25.00	-0.22	25.57	24.91	25.00	-2.22
5	27.07	29.34	28.00	28.54	1.93	28.35	26.30	28.28	-0.25	28.68	28.32	28.04	-2.25
10	30.15	33.44	32.73	32.28	-1.40	31.14	29.63	31.75	1.96	32.16	31.98	31.24	-2.86
15	34.58	37.73	35.99	36.23	0.66	34.87	33.59	35.41	1.54	35.71	35.02	34.63	-3.04
20	39.01	41.36	39.54	40.41	2.22	38.86	37.00	39.28	1.08	38.68	38.97	38.21	-1.23
25	42.89	46.26	44.19	44.83	1.46	42.34	41.80	43.37	2.43	42.78	43.19	41.99	-1.86
30	48.13	51.61	48.39	49.51	2.32	47.00	46.63	47.70	1.50	47.22	46.74	45.98	-2.62
35	53.81	57.12	52.75	54.45	3.24	51.91	51.94	52.27	0.70	50.99	51.58	50.20	-1.55
40	59.93	62.16	58.76	59.68	1.58	57.36	56.59	57.10	-0.46	56.12	56.67	54.65	-2.61
45	65.13	68.72	65.09	65.21	0.19	61.91	62.78	62.21	0.49	61.39	62.16	59.36	-3.31
50	72.02	75.71	70.62	71.06	0.62	68.13	69.38	67.60	-0.78	67.22	66.96	64.33	-4.29
55	79.52	81.87	77.95	77.24	-0.90	74.98	75.02	73.31	-2.23	72.02	73.08	69.58	-3.37
60	85.82	90.11	86.12	83.78	-2.71	80.73	82.75	79.34	-1.73	78.46	79.67	75.13	-4.24
65	94.21	99.08	94.84	90.70	-4.36	88.57	90.95	85.71	-3.24	85.35	85.13	80.99	-5.10
70	103.37	106.81	102.13	98.01	-4.03	96.89	99.71	92.44	-4.59	91.17	92.82	87.19	-4.37
75	113.33	116.63	111.54	105.75	-5.19	104.25	107.51	99.55	-4.50	98.83	100.73	93.73	-5.16
80	121.80	127.66	121.72	113.92	-6.41	113.55	117.51	107.08	-5.70	106.89	107.62	100.64	-5.85
85	130.26	135.68	129.91	122.57	-5.65	124.07	128.57	115.02	-7.29	113.70	116.59	107.94	-5.07
90										122.45	125.97	115.65	-5.56
95										131.43	135.97	123.79	-5.81

[a] difference between model and solid [b] difference between model and liquid

Table E5 Comparison between the temperature from the model and the experimental data of surimi in 0.75% salt-2% sugar-4% starch liquid

Time (s)	Tempera-ture of pure liquid (°C)	Temperature of each component at volume fraction (°C)											
		0.2				0.4				0.6			
		liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [a]	liquid	solid	model	%dif. [a]
0	25.15	24.95	25.11	25.00	0.22	24.56	25.15	25.00	1.77	24.32	24.53	25.00	2.79
5	27.07	26.32	27.02	28.82	9.50	26.41	27.29	28.86	9.27	25.97	26.02	28.90	11.29
10	30.15	30.99	31.11	32.88	6.11	29.89	30.88	32.98	10.35	30.55	29.68	33.10	8.35
15	34.58	34.50	35.11	37.20	7.85	34.51	35.50	37.39	8.37	34.54	34.48	37.61	8.88
20	39.01	40.29	39.94	41.79	3.73	39.56	40.55	42.11	6.43	39.56	39.61	42.46	7.32
25	42.89	44.47	43.94	46.68	4.97	45.20	45.02	47.14	4.29	45.13	45.14	47.66	5.62
30	48.13	49.94	49.36	51.87	3.87	49.89	51.14	52.52	5.28	49.82	49.97	53.26	6.92
35	53.81	56.19	56.46	57.39	2.14	56.37	57.73	58.28	3.38	56.23	56.57	59.28	5.43
40	59.93	61.50	62.45	63.26	2.86	63.52	64.87	64.43	1.43	63.22	63.71	65.75	3.99
45	65.13	68.02	69.45	69.50	2.17	69.52	71.06	71.00	2.12	70.73	70.05	72.70	2.78
50	72.02	74.34	77.46	76.14	2.42	77.77	79.52	78.02	0.33	76.63	77.67	80.17	4.62
55	79.52	82.31	85.46	83.19	1.07	84.97	88.13	85.53	0.66	85.57	87.12	88.20	3.07
60	85.82	90.58	95.06	90.69	0.13	92.85	96.37	93.55	0.76	95.50	96.32	96.83	1.39
65	94.21	98.36	102.68	98.67	0.32	103.58	107.66	102.13	-1.40	103.81	108.35	106.10	2.21
70	103.37	107.38	111.68	107.15	-0.22	115.26	120.22	111.29	-3.44	115.75	119.18	116.07	0.28
75	113.33	116.84	119.84	116.17	-0.58	126.17	131.10	121.09	-4.02	125.83	130.85	126.78	0.76
80	121.80	126.34	130.63	125.75	-0.47								
85	130.26												

[a] difference between model and liquid

Table E6 Comparison between the temperature from the model and the experimental data of unsalted potato and white radish in 0.75% salt-2% sugar-4% starch liquid

Time	Temperature of each component at volume fraction (°C)														
(s)	0.2					0.4					0.6				
	liquid	potato	WR#	model	%dif. [a]	liquid	potato	WR#	model	%dif. [a]	liquid	potato	WR#	model	%dif. [a]
0	24.87	24.47	25.02	25.00	0.51	24.80	24.62	24.69	25.00	0.81	25.31	25.35	24.86	25.00	-1.23
5	25.93	25.79	26.41	28.22	8.80	28.06	27.66	27.55	27.64	-1.49	27.77	27.66	25.53	27.10	-2.39
10	29.23	28.46	29.05	31.61	8.14	31.61	30.29	29.96	30.42	-3.78	30.48	29.60	27.80	29.31	-3.83
15	32.23	32.16	32.49	35.19	9.17	34.65	33.77	33.30	33.34	-3.80	32.71	32.16	30.73	31.62	-3.33
20	36.01	36.23	36.19	38.96	8.22	38.72	37.69	36.89	36.41	-5.97	35.64	34.95	33.88	34.04	-4.48
25	40.00	39.60	40.22	42.95	7.37	43.04	41.06	40.88	39.63	-7.91	38.90	38.02	37.25	36.59	-5.95
30	43.41	44.21	43.70	47.15	8.62	46.78	45.50	44.29	43.03	-8.01	41.50	40.59	40.29	39.25	-5.43
35	48.06	49.08	48.28	51.58	7.33	51.72	50.04	48.86	46.60	-9.90	45.06	43.99	44.14	42.04	-6.68
40	52.93	54.32	53.26	56.26	6.29	56.81	55.06	53.66	50.35	-11.37	48.79	47.62	48.35	44.97	-7.83
45	58.21	58.86	57.44	61.19	5.13	60.23	59.27	57.69	54.30	-9.85	52.49	50.66	51.83	48.04	-8.47
50	62.45	64.76	63.04	66.40	6.31	64.92	64.87	63.04	58.45	-9.97	55.60	54.54	55.45	51.26	-7.81
55	68.35	70.95	69.12	71.89	5.17	68.11	69.81	68.79	62.82	-7.78	59.67	58.68	59.32	54.64	-8.43
60	74.65	76.48	75.57	77.68	4.05	73.52	75.79	74.91	67.41	-8.32	63.92	62.97	63.31	58.18	-8.98
65	80.00	83.70	81.25	83.78	4.73	79.98	81.53	80.00	72.24	-9.69	67.40	66.52	67.73	61.89	-8.18
70	87.03	91.39	88.65	90.23	3.67	86.16	87.45	85.70	77.31	-10.27	71.94	71.21	72.37	65.78	-8.57
75	94.69	99.67	96.59	97.03	2.47	93.82	93.07	92.74	82.65	-11.90	76.52	76.12	77.27	69.85	-8.71
80	101.21	106.78	103.59	104.20	2.95	99.40	101.78	98.16	88.26	-11.20	81.28	80.22	82.22	74.13	-8.80
85	109.49	115.82	112.34	111.76	2.08	105.40	108.25	105.56	94.17	-10.66	85.42	85.60	87.66	78.61	-7.97
90	118.72	125.71	122.16	119.74	0.86	111.48	115.23	112.32	100.37	-9.96	90.44	91.28	92.40	83.31	-7.88
95	128.72	134.25	130.66	128.16	-0.43	118.36	122.40	119.57	106.90	-9.68	95.86	97.22	97.04	88.24	-7.95
100						123.58	127.56	124.65	113.76	-7.94	100.29	102.23	103.26	93.41	-6.87
105						129.34	132.84	129.35	120.98	-6.46	106.19	108.76	109.99	98.82	-6.94
110											112.23	114.50	116.97	104.50	-6.89
115											117.11	120.21	121.68	110.46	-5.68
120											125.81	128.79	129.73	116.70	-7.24

[a] difference between model and liquid
white radish

Table E7 Comparison between the temperature from the model and the experimental data of unsalted potato and surimi in 0.75% salt-2% sugar-4% starch liquid

Time (s)	Temperature of each component at volume fraction (°C)														
	0.2					0.4					0.6				
	liquid	potato	surimi	model	%dif. [a]	liquid	potato	surimi	model	%dif. [a]	liquid	potato	surimi	model	%dif. [b]
0	25.17	25.48	25.22	25.00	-1.90	25.13	24.86	25.50	25.00	0.57	23.92	24.51	24.02	24.00	0.34
5	28.86	29.89	29.52	28.58	-4.39	28.13	27.07	28.65	28.37	4.81	26.19	26.04	26.32	27.10	3.48
10	32.93	33.52	33.52	32.37	-3.41	31.47	29.45	32.05	31.96	8.51	29.19	29.49	29.12	30.41	4.15
15	36.45	36.63	37.80	36.40	-0.63	34.29	32.71	35.02	35.77	9.35	33.00	33.33	33.99	33.93	2.80
20	41.25	40.73	41.50	40.67	-0.16	38.32	36.34	38.94	39.82	9.58	36.78	37.22	37.95	37.68	2.46
25	46.04	45.24	46.37	45.19	-0.10	42.38	40.07	43.19	44.13	10.11	39.93	40.66	43.15	41.68	4.39
30	50.37	49.96	51.72	49.99	0.06	45.93	43.30	46.81	48.70	12.48	44.25	45.17	47.16	45.94	3.83
35	55.90	53.96	56.12	55.08	2.09	50.77	47.77	51.72	53.57	12.15	48.72	50.11	52.20	50.49	3.63
40	61.94	59.45	62.09	60.48	1.73	56.01	52.45	57.14	58.74	11.98	53.48	54.32	56.40	55.33	3.45
45	68.35	65.35	68.61	66.20	1.31	61.69	56.59	61.80	64.24	13.51	57.44	58.93	62.07	60.49	5.31
50	74.03	70.37	74.29	72.27	2.71	66.34	62.09	67.91	70.08	12.88	62.71	64.04	67.43	65.98	5.22
55	81.32	77.03	81.76	78.70	2.17	72.31	67.73	74.18	76.30	12.65	68.54	70.67	73.70	71.84	4.82
60	88.79	83.74	89.23	85.53	2.14	78.86	72.78	81.14	82.90	13.90	73.30	75.43	79.97	78.08	6.53
65	95.50	91.39	98.10	92.77	1.50	84.43	79.45	87.22	89.92	13.18	79.08	81.46	85.92	84.74	7.15
70	104.43	98.02	105.60	100.44	2.47	91.94	86.85	95.35	97.38	12.13	85.97	86.92	92.08	91.83	6.81
75	114.18	106.89	115.64	108.58	1.58	99.78	94.73	104.25	105.32	11.18	91.91	94.21	99.81	99.38	8.13
80	124.95	116.74	126.81	117.21	0.40	108.10	101.58	111.83	113.75	11.98	99.60	101.95	105.77	107.43	7.87
85	131.71	125.59	133.99	126.36	0.61	115.17	110.70	121.94	122.71	10.85	107.88	112.39	115.21	116.01	7.54
90						124.98	120.51	132.89	132.24	9.73	116.81	121.37	124.08	125.15	7.14
95						130.80	126.33	139.85	142.37	12.70	125.32	129.16	131.00	134.90	7.64

[a] difference between model and potato [b] difference between model and liquid

Table E8 Comparison between the temperature from the model and the experimental data of unsalted white radish and surimi in 0.75% salt-2% sugar-4% starch liquid

Time	Temperature of each component at volume fraction (°C)														
(s)	0.2					0.4					0.6				
	liquid	WR	surimi	model	%dif. [a]	liquid	WR	surimi	model	%dif. [a]	liquid	WR	surimi	model	%dif. [a]
0	25.10	24.96	25.28	25.00	-0.41	25.04	24.43	25.39	25.00	-0.16	25.24	25.13	25.45	25.00	-0.94
5	27.69	28.10	27.41	28.57	3.17	27.25	26.59	27.22	28.35	4.04	28.72	27.95	29.85	28.13	-2.06
10	30.95	31.65	31.25	32.36	4.54	31.14	30.66	31.28	31.92	2.51	31.76	31.54	32.86	31.46	-0.93
15	35.24	36.41	36.41	36.38	3.23	35.24	33.99	35.53	35.71	1.34	35.93	35.82	36.85	35.01	-2.56
20	39.96	41.58	41.94	40.64	1.68	38.68	38.46	39.23	39.74	2.74	40.40	40.44	41.10	38.80	-3.96
25	45.24	46.04	46.70	45.15	-0.19	43.30	43.26	44.21	44.03	1.68	44.29	44.47	44.84	42.84	-3.27
30	49.78	52.05	53.15	49.95	0.33	48.21	47.47	49.63	48.58	0.79	49.56	49.85	49.78	47.14	-4.88
35	55.93	58.50	60.11	55.03	-1.62	52.60	52.93	54.29	53.43	1.58	55.17	55.57	55.31	51.73	-6.23
40	62.53	65.28	66.15	60.42	-3.37	58.35	58.68	60.73	58.58	0.40	61.43	60.66	60.00	56.62	-7.84
45	68.35	71.06	74.07	66.14	-3.24	64.51	65.20	67.73	64.06	-0.68	66.78	67.58	66.52	61.83	-7.41
50	76.23	78.57	82.67	72.20	-5.28	71.36	70.62	73.77	69.89	-2.05	73.37	74.36	73.00	67.38	-8.16
55	84.76	86.74	92.09	78.63	-7.23	77.11	77.88	81.87	76.09	-1.32	81.06	80.66	80.66	73.30	-9.58
60	92.23	93.66	100.22	85.45	-7.35	84.40	85.17	90.15	82.68	-2.04	87.58	89.05	87.25	79.61	-9.10
65	102.60	103.30	111.32	92.69	-9.66	92.67	92.02	99.60	89.68	-3.23	96.45	96.15	98.10	86.33	-10.49
70	113.04	113.19	122.56	100.36	-11.22	99.85	101.32	107.84	97.13	-2.72	105.68	106.08	107.84	93.50	-11.52
75	122.56	125.17	132.78	108.50	-11.47	109.52	111.61	119.08	105.05	-4.08	113.96	116.67	116.37	101.14	-11.25
80	130.94	135.29	141.00	117.13	-10.55	119.74	122.75	131.10	113.48	-5.23	124.98	125.71	127.77	109.28	-12.56
85						128.35	132.56	141.36	122.44	-4.61					

[a] difference between model and liquid

Table E9 Comparison between the temperature from the model and the experimental data of salted potato and salted white radish in 0.75% salt-2% sugar-4% starch liquid

Time	Temperature of each component at volume fraction (°C)														
(s)	0.2					0.4					0.6				
	liquid	potato	WR	model	%dif.[a]	liquid	potato	WR	model	%dif.[a]	liquid	potato	WR	model	%dif.[a]
0	25.46	24.89	25.06	25.00	-1.79	25.12	24.89	25.06	25.00	-0.48	25.46	24.89	25.06	25.00	-1.79
5	29.80	29.88	29.29	28.55	-4.18	28.15	27.25	27.98	28.32	0.61	28.72	27.25	27.98	28.09	-2.18
10	33.24	33.50	34.73	32.31	-2.79	31.50	30.88	30.29	31.84	1.08	31.80	30.88	30.29	31.38	-1.31
15	38.13	35.50	37.91	36.29	-4.82	31.91	31.50	30.73	35.58	11.51	35.24	31.50	30.73	34.87	-1.06
20	42.02	39.85	42.05	40.51	-3.57	35.24	35.50	34.58	39.54	12.21	38.13	35.50	34.58	38.57	1.15
25	46.34	43.66	47.36	44.99	-2.92	39.01	39.85	37.91	43.74	12.13	42.02	39.85	37.91	42.51	1.17
30	50.66	48.61	51.43	49.72	-1.85	42.31	43.66	42.05	48.20	13.93	46.34	43.66	42.05	46.69	0.75
35	54.73	53.88	55.93	54.74	0.02	46.67	48.61	47.36	52.93	13.42	50.66	48.61	47.36	51.13	0.92
40	59.71	58.35	61.98	60.05	0.57	51.28	53.88	51.43	57.95	13.00	54.73	53.88	51.43	55.84	2.04
45	64.91	64.43	68.50	65.68	1.19	56.37	58.35	55.93	63.27	12.23	59.71	58.35	55.93	60.85	1.91
50	69.52	70.88	74.43	71.64	3.05	60.81	64.43	61.98	68.91	13.33	64.91	64.43	61.98	66.17	1.94
55	75.39	76.37	81.61	77.96	3.41	66.67	70.88	68.50	74.90	12.35	69.52	70.88	68.50	71.82	3.30
60	81.80	83.63	89.41	84.65	3.49	72.89	76.37	74.43	81.25	11.46	75.39	76.37	74.43	77.82	3.23
65	87.25	91.32	96.45	91.74	5.14	78.21	83.63	81.61	87.98	12.50	81.80	83.63	81.61	84.19	2.93
70	94.36	99.56	102.28	99.24	5.18	85.09	91.32	89.41	95.13	11.80	87.25	91.32	89.41	90.96	4.25
75	102.16	106.59	111.29	107.20	4.93	92.56	99.56	96.45	102.71	10.96	94.36	99.56	96.45	98.15	4.01
80	110.18	115.31	119.21	115.62	4.93	98.86	106.59	102.28	110.74	12.02	102.16	106.59	102.28	105.78	3.55
85	119.92	121.91	128.21	124.54	3.85	106.70	115.31	111.29	119.27	11.78	110.18	115.31	111.29	113.89	3.37
90	128.45	132.56	136.25	134.00	4.32	115.50	121.91	119.21	128.32	11.10	116.92	121.91	119.21	122.51	4.78
95						123.32	130.62	129.21	137.91	11.83	125.45	132.56	128.21	131.65	4.95
100						131.02	141.34	139.40	148.08	13.02					

[a] difference between model and liquid

Table E10 Comparison between the temperature from the model and the experimental data of salted potato and surimi in 0.75% salt-2% sugar-4% starch liquid

Time	Temperature of each component at volume fraction (°C)														
(s)	0.2					0.4					0.6				
	liquid	potato	surimi	model	%dif. [a]	liquid	potato	surimi	model	%dif. [a]	liquid	potato	surimi	model	%dif. [a]
0	24.78	25.07	25.46	25.00	0.90	25.21	24.99	24.89	25.00	-0.83	25.58	25.17	25.39	25.00	-2.25
5	26.89	27.40	29.01	28.68	6.68	28.32	28.10	29.23	28.59	0.98	29.28	30.95	30.06	28.49	-2.72
10	30.77	31.17	32.75	32.59	5.92	34.91	35.90	37.25	32.43	-7.1	34.58	35.35	34.58	32.22	-6.82
15	34.03	34.29	35.62	36.75	7.98	38.94	40.66	41.14	36.52	-6.21	38.94	39.52	39.27	36.22	-6.98
20	38.21	38.57	40.78	41.16	7.73	42.45	44.62	46.23	40.88	-3.7	43.63	44.32	44.43	40.51	-7.14
25	42.71	43.26	45.17	45.84	7.33	47.25	49.96	51.80	45.54	-3.62	47.44	48.94	48.72	45.10	-4.92
30	47.51	47.29	50.86	50.82	6.97	52.42	55.68	57.69	50.51	-3.64	52.71	54.25	54.58	50.03	-5.09
35	51.69	52.75	54.23	56.11	8.56	59.24	60.25	62.58	55.81	-5.78	58.10	60.26	60.84	55.30	-4.81
40	57.11	58.68	61.90	61.73	8.09	62.64	66.48	69.05	61.47	-1.87	63.92	65.28	66.30	60.96	-4.64
45	63.00	65.20	68.58	67.69	7.44	69.16	73.15	76.30	67.50	-2.4	68.54	72.31	73.19	67.01	-2.22
50	68.02	70.84	73.45	74.03	8.83	74.47	79.96	82.20	73.94	-0.71	74.95	79.52	81.10	73.50	-1.92
55	74.91	78.57	80.95	80.76	7.81	81.69	85.75	90.07	80.81	-1.07	82.72	86.01	89.74	80.46	-2.74
60	81.65	86.45	88.30	87.91	7.67	87.71	93.66	98.79	88.14	0.49	90.55	94.36	97.33	87.91	-2.91
65	87.16	93.30	95.59	95.50	9.58	95.43	102.16	106.15	95.96	0.56	98.28	103.92	105.62	95.90	-2.42
70	94.35	101.53	104.30	103.57	9.78	102.82	109.71	113.93	104.30	1.44	108.19	111.13	112.86	104.45	-3.45
75	102.74	110.49	112.66	112.14	9.15	111.90	119.45	122.25	113.20	1.17	114.28	119.29	122.35	113.62	-0.58
80	111.67	119.37	122.71	121.24	8.57	118.25	128.35	130.41	122.70	3.76	121.40	126.90	127.50	123.44	1.69
85	120.22	128.71	131.40	130.91	8.89	126.60	137.25	139.57	132.84	4.92	131.75	134.31	135.50	133.97	1.69
90	126.35	136.98	139.58	141.18	11.74										

[a] difference between model and liquid

Table E11 Comparison between the temperature from the model and the experimental data of salted white radish and surimi in 0.75% salt-2% sugar-4% starch liquid

Time	Temperature of each component at volume fraction (°C)														
(s)	0.2					0.4					0.6				
	liquid	WR	surimi	model	%dif. [a]	liquid	WR	surimi	model	%dif. [a]	liquid	WR	surimi	model	%dif. [a]
0	25.46	25.06	24.89	25.00	-1.79	25.12	25.06	24.89	25.00	-0.48	25.46	25.06	24.89	25.00	-1.79
5	28.13	28.32	28.28	28.78	2.32	27.18	27.25	28.86	28.78	5.89	27.95	28.13	28.61	28.78	2.98
10	31.28	32.86	32.31	32.81	4.87	30.18	30.40	31.87	32.82	8.72	30.84	31.50	32.02	32.84	6.48
15	35.60	37.25	36.04	37.08	4.15	34.76	33.88	35.64	37.13	6.80	35.35	36.30	37.03	37.20	5.23
20	40.22	42.09	40.92	41.63	3.49	38.54	38.43	40.26	41.73	8.29	40.33	40.37	41.25	41.87	3.82
25	45.20	46.15	46.30	46.46	2.78	43.63	43.41	45.57	46.65	6.92	44.43	45.86	47.03	46.89	5.53
30	49.49	51.32	50.70	51.59	4.25	48.86	48.83	49.89	51.90	6.21	50.11	51.87	53.44	52.28	4.33
35	54.24	57.11	56.85	57.05	5.18	53.44	53.55	55.93	57.50	7.60	56.15	56.85	58.83	58.06	3.39
40	59.43	63.70	63.44	62.85	5.76	59.38	59.85	62.67	63.49	6.93	61.32	63.70	64.19	64.27	4.81
45	65.85	68.94	70.62	69.02	4.81	65.97	66.85	69.96	69.88	5.93	68.35	70.17	71.36	70.93	3.77
50	71.92	76.23	76.70	75.58	5.08	71.54	72.82	76.26	76.71	7.23	75.50	77.72	78.81	78.08	3.42
55	78.72	83.85	84.84	82.54	4.86	78.54	80.66	84.47	84.00	6.96	81.83	85.82	86.18	85.75	4.79
60	86.58	90.37	93.74	89.95	3.90	85.82	89.23	93.55	91.79	6.95	90.29	93.65	95.59	93.99	4.09
65	94.85	98.72	100.99	97.83	3.14	93.88	96.70	101.47	100.10	6.63	99.38	103.62	104.91	102.83	3.48
70	102.56	108.24	110.32	106.20	3.55	100.62	106.52	112.20	108.98	8.31	109.05	111.08	113.72	112.32	3.00
75	110.03	118.32	121.49	115.10	4.60	109.56	116.41	123.66	118.47	8.13	117.36	120.55	122.43	122.51	4.38
80	118.86	126.45	131.94	124.55	4.79	119.01	124.54	133.55	128.59	8.05	125.58	131.64	135.16	133.44	6.26
85	126.58	134.25	139.85	134.61	6.34	128.46	132.67	143.44	139.41	8.52					

[a] difference between model and liquid

APPENDIX F

EXAMPLE OF CALCULATION

Example of calculation for σ_{eff} and temperature prediction of the mixture of salted potato and surimi in 0.75% salt- 2% sugar- 4% starch at 0.2 vf was demonstrated as followed:

1. σ_{eff}

   1.1 Estimation of σ of 0.75% salt- 2% sugar- 4% starch from equation 4.1

   $$\sigma = 0.379 + 0.871Sa - 0.0371St - 0.0298Su + 0.00164T + 0.0251SaT$$
   $$= 0.379 + 0.871(0.75) - 0.0371(4) - 0.0298(2) + 0.00164T + 0.0251(0.75)T$$
   $$= 0.8242 + 0.0205T$$

   1.2 Regression of σ of solid and temperature data as shown in Table 4.10

   σ of salted potato $= 0.1863 + 0.0170T$

   σ of surimi $= 0.4968 + 0.0256T$

   1.3 Calculation of σ_{eff} based on circuit-analogy concept

   dimension of ohmic cell was 2.65-cm diameter and 5.5-cm length

   $L = 0.055$ m

   $A = 0.00055$ m^2

   from equation 2.22-2.26

   Resistance in series:

$$R_{IS} = \frac{0.055(1-0.2^{\frac{1}{3}})}{(0.00055)(0.8284+0.0205T)}$$

   Resistance in parallel:

$$R_{IP} = \frac{0.055(0.2^{\frac{1}{3}})}{(0.00055)(0.8284+0.0205T)}$$

$$R_{sP1} = \frac{0.055(0.2^{\frac{1}{3}})}{(0.00055)(0.1^{\frac{2}{3}})(0.1863+0.0170T)}$$

for surimi: $$R_{sP2} = \frac{0.055(0.2^{\frac{1}{3}})}{(0.00055)(0.1^{\frac{2}{3}})(0.4968 + 0.0256T)}$$

from equation 2.23, the combined resistance in parallel was

$$R_p = \frac{1}{\frac{1}{R_{lP}} + \sum_{i=1}^{2} \frac{1}{R_{sPi}}}$$

from equation 2.22, the total resistance was

$$R = R_{lS} + R_P$$

The total resistance obtained as a function of temperature. Then, the σ_{eff} was calculated from equation 2.4.

$$\sigma = (1/R)(L/A)$$

and obtained as: $$\sigma_{eff} = 0.7383 + 0.0216T$$

2. Temperature prediction

from equation 2.30:

$$T = \frac{1}{b}\left\{(a + bT_0)\exp\left[\frac{bE^2t}{\rho C_p}\right] - a\right\}$$

substituted a = 0.7383 S/m, b = 0.0216 S/m°C, T_0 = 25°C

ρ = 1037 kg/m^3, C_p = 3883 J/kg°C, E = 1500 V/m

t = time (s)

The temperature values could be obtained according to the time increasing.

VITA

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