The changes and interactions of electrical conductivity, water activity and viscosity in ohmic heat treatment.

于乃華、王維麒

E-mail: 9808760@mail.dyu.edu.tw

ABSTRACT

In this research, ohmic heating treatment was studied to observe the changes and interactions of electrical conductivity, water activity, and viscosity. Wheat starch, corn starch, potato starch were used as experimental materials. Starch and distilled water were mixed as the ratio 7.97%(w/w), 6.53%, and 5.55% to form starch suspensions and 0.3%(w/w)NaCl was added as electrolyte. Before the experiments, starch suspensions were boiled to 100°C to make it fully-gelatinized and cooled to 30°C. The heating range was 30 ~ 80°C. In ohmic heat, samples were heated by using alternating current and the voltage gradient was 4.67 V/cm. The electrical conductivity increased as temperature increased, and in high temperature range the tendency turned nonlinear. The m values of electrical conductivity was similar, and the higher suspension concentrations, the lower in electrical conductivity. For water activity, samples were heated by circulating water bath. Water activity decreased slightly as temperature was between 30 ~70°C,but between 70 ~80°C, the water activity increased because of the raise of free water. Viscosity of samples was determined by Brookfield viscometer and hot plate. High viscosity occurred at high starch concentration, and the higher in temperature, the lower in viscosity. In regression analysis, the relationship among the electrical conductivity, water activity, and viscosity were clear when the starch concentrations were low. For the interrelationship of the three properties, the electrical conductivity and water activity was negative-related because of gelation, whereas the relation between Water activity and viscosity was not clear. The electrical conductivity and viscosity was negative-related because of the increased rate of water flow. In addition, 70°Cwas a critical point for water activity where showed reverse tendency. The wheat starch was the most suitable material for analyzing the relationship among the electrical conductivity, water activity, and viscosity.

Keywords : Ohmic heating ; electrical conductivity ; water activity ; viscosity

Table of Contents

REFERENCES

1.王峻禧 (1997) 果汁導電度與含蘋果粒兩相系統電阻加熱之研究。台灣大學食品科技研究所博士論文，台北，台灣。 2.王維麒 (1999) 電阻加熱技術之原理及影響因子。食品工業，31 (2) : 8 ~ 14。 3.王維麒 (2000) 食品物性技術實驗。pp. 16 ~ 21。 4.王正方、王惠珠、李嘉展、孫芳明、陳政雄、劉世銓、駱錫能、韓建國、蘇正德 (2001) 新編食品化學。華格那出版社，pp. 123 ~ 147。 5.施明智 (1994) 食物學原理。藝軒圖書出版社，pp. 167 ~ 179。 6.高寶珠 (1998) 黏度量測與標準。化工技術，6 (1) : 148 ~ 156。 7.陳加忠、曹之祖 (1997) 兩種食品水活性測定與適用模式之評估。農林學報，46(3) : 73 ~ 90。 8.郭晟贊 (1998) 組織結構對蔬菜電導度之影響。台灣大學食品科技研究所碩士論文，台北，台灣。 9.曾道一 (1993) 澱粉之理化性質。食品工業，25 (3) : 33 ~ 42。 10.張為憲、李敏雄、呂政義、張永和、陳昭雄、孫璐西、陳怡宏、張基郁、顏國欽、林志城、林慶文 (1996) 食品化學。華香園出版社，pp. 20 ~ 26。 11.楊炳輝 (1999a) 食品電阻加熱技術之應用及其發展。食品工業，31 (2) : 15 ~ 20。 12.楊炳輝 (1999b) 含顆粒流體食品電阻加熱製程設計之考量因素。食品工業，31 (2) : 1 ~ 7。 13.謝奇聰、傅文榮 (1999) 三維異相系統歐姆加熱之電腦模擬。食品科學，26 (4):404 ~ 410。 14.Anderson, A.K. and Finkelatein, R. (1919) A study of the electropure process of treating milk. J. Dairy Sci. 2 : 374 ~ 406. 15.Anese, M., Shtylla, I., Torreggiani, D., Maltini, E. (1996) Water activity and viscosity—relations with glass transition temperatures in model food systems. Thermochim. Acta 275 : 131 ~ 137. 16.Biss, C.H., Coombes, S.A., and Skudder, P.J. (1989) The development and application of ohmic heating for the continuous processing of particulate foodstuffs. In ‵Process Engineering in the Food Industry.′ ed. R. W. Field and J. A. Howell, pp.17 ~ 27. 17.Cho, H.Y., Yousef, A.E., and Sastry, S.K. (1999) Kinetic of inactivation of Bacillus subtills spores by continuous or intermittent ohmic and conventional heating. Biotechnol. Bioeng., 62 : 368 ~ 372. 18.de Alwis, A.A.P. and Fryer, P.J. (1992) Operability of the ohmic heating process : electric

conductivity effects. J. Food Eng. , 15 : 21 ~ 48. 19.Fryer, P.J., de Alwis, A.A.P., Koury, E., Stapley, A.G.F. and Zhang, L. (1993) Ohmic processing of solid-liquid mixtures : heat generation and convection effects. J. Food Process Eng., 18 : 101 ~ 125. 20.Halden, K. ,De Alwis, A.A.P. and Fryer, P.J. (1990) Change in the electrical conductivity of foods during ohmic heating. Int. J. Food Sci. Technol., 25 : 9 ~ 25. 21.Jaska, E. (1971) Starch gelatinization as detected by proton magnetic resonance. Cereal Chem., 48 : 437 ~ 444. 22.Khalaf, W.G. and Sastry, S.K. (1996) Effect of fiuld viscosity on the ohmic heating rate of solid-liquid mixtures. J. Food Eng., 27 : 145 ~ 158. 23.Marcotte, M. and Piette, J.P.G. (1998) Electrical conductivities of hydrocolloid solutions. J. Food Process Eng., 21 : 503 ~ 520. 24.Marcotte, M., Ramaswamy, H.S. and Piette, J.P.G. (1999) Ohmic heating behavior of hydrocolloid solutions. Food Res. Int., 31 : 493 ~ 502. 25.Mazurkiewicz, J., Tomasik, P., Zaplotny, J. (2001) Relationships between water activity and viscosity of solutions. Food Hydrocoll., 15 : 43 ~46. 26.Palaniappan, S. and Sastry, S.K. (1991a) Electrical conduc -tivities of selected solid foods during ohmic heating. J. Food Process Eng., 14 : 221 ~ 236. 27.Palaniappan, S. and Sastry, S.K. (1991b) Electrical conductivity of selected juices : influences of temperature, solids content, applied voltage, and particle size. J. Food Process Eng., 14 : 247 ~ 260. 28.Palaniappan, S. and Sastry, S.K. (1992) Ohmic heating of liquid-particle mixtures. Food Technol., December : 64 ~ 67. 29.Palaniappan, S., Sastry, S.K. and Richter E.R. (1990) Effect of electricity on microorganisms : a review. J. Food Process. Preserv., 14 : 393 ~ 414. 30.Palaniappan, S., Sastry, S.K. and Richter E.R. (1992) Effects of electroconductive heat treatment and electrical pretreatment on thermal death kinetics of selected microorganisms. Biotechnol. Bioeng., 39 : 225 ~232. 31.Wang, W. C. (1995) Ohmic heating of foods : physical properties and applications. Ph. D. Dissertation, The Ohio State University, Columbus , OH. 32.Wang, W.C. 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 : 299 ~ 309. 33.Wang, W.C. and Sastry, S.K. (1997a) Starch gelatinization in ohmic heating. J. Food Eng., 34 : 225 ~ 242. 34.Wang, W.C. and Sastry, S.K. (1997b) Vegetables during multiple thermal treatments. J. Food Process Eng., 20 : 499 ~ 516.