運用反應曲面法優化甜麵包預發酵與預烤焙冷凍麵糰之配方

蔡柏松

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大綱

摘　要

本篇研究旨在利用反應曲面法(RSM)最佳化甜麵包即預發酵(RTP)與即預烘烤(RSM)冷凍麵糰之配方。將糖、水、油脂及酵母選為研究因子，並採用中心組合設計設定各因子的測試範圍。比較新鮮麵糰、RTP 麵糰及 RTB 麵糰製作之甜麵包品質，包括麵包高度、體積、水分含量、外觀顏色與內部硬度。結果顯示，新鮮麵糰與 RTP 麵糰所製得的麵包，其體積與高度均高於 RTB 麵糰，且硬度較低，表示 RTP 麵糰的冷凍穩定性優於 RTB 麵糰。影響 RTP 與 RTB 麵糰品質的最重要配方因子為糖、水及酵母，其中麵包體積、高度與硬度等代表性品質指標主要受糖與酵母影響。根據期望函數(Desirability)選出最佳化配方：新鮮麵糰與 RTP 麵糰宜採低糖高水配方，RTB 麵糰則宜採中等糖低水配方。綜合三種麵糰的單一最佳化配方(以100g小麥粉為基準)為：糖16.55g、水50.27g、酥油20.01g、酵母3.50g，可獲得優良的冷凍穩定性。

關鍵字：冷凍麵糰、甜麵包、最佳化、配方、反應曲面法

參考文獻

AACC. (2010). *Approved methods of analysis* (11th ed.). St. Paul, MN, USA: American Association of Cereal Chemists. Method 08-01.01, Method 10-05.01, Method 42-50.01, Method 44-15.02, Method 56-11.02, Method 74-09.01.

Akbarian, M., Dehkordi, M. S. M., Ghasemkhani, N., Koladoozi, M., Niknam, O., & Morshedi, A. (2015). Hydrocolloids and cryoprotectant used in frozen dough and effect of freezing on yeast survival and dough structure: A review. *International Journal of Life Sciences, 9*, 1–7.

Autio, K., & Sinda, E. (1992). Frozen doughs: Rheological changes and yeast viability. *Cereal Chemistry, 69*, 409–413.

Ayati, S. V., Hamdami, N., & Le-Bail, A. (2016). Frozen sangak dough and bread properties: Impact of pre-fermentation and freezing rate. *International Journal of Food Properties, 20*, 782–791.

Chen, G., Swenson, J., Van der Meulen, S., & Villman, S. (2013). Frozen dough and bread: The activities of water and ice crystals. *New Food, 16*, 67–68, 70-71.

Choi, D. R., Lee, J. H., Yoon, Y. C., & Lee, S. K. (2005). Effect of vital wheat gluten on the quality characteristics of the dough frozen after 1st fermentation. *Korean Journal of Food Science and Technology, 37*, 55–60.

Frauenlob, J., Moriano, M. E., Innerkofler, U., D'Amico, S., Lucisano, M., & Schoenlechner, R. (2017). Effect of physicochemical and empirical rheological wheat flour properties on quality parameters of bread made from pre-fermented frozen dough. *Journal of Cereal Science, 77*, 58–65.

Gharaie, Z., Azizi, M. H., Barzegar, M., & Aghagholizade, R. (2015). Effects of hydrocolloids on the rheological characteristics of dough and the quality of bread made from frozen dough. *Journal of Texture Studies, 46*, 365–373.

Giannou, V., Kessoglou, V., & Tzia, C. (2003). Quality and safety characteristics of bread made from frozen dough. *Trends in Food Science & Technology, 14*, 99–108.

Hino, A., Takano, H., & Tanaka, Y. (1987). New freeze-tolerant yeast for frozen dough preparations. *Cereal Chemistry, 64*, 269–275.

Jang, K. J., Hong, Y. E., Moon, Y. J., Jeon, S. J., Angalat, S., & Kweon, M. (2018). Exploring the applicability of tamarind gum for making gluten-free rice bread. *Food Science and Biotechnology, 27*, 1639–1648.

Kenny, S., Wehrle, K., Dennehy, T., & Arendt, E. K. (1999). Correlations between empirical and fundamental rheology measurements and baking performance of

frozen bread dough. *Cereal Chemistry, 76*, 421–425.

Kittisuban, P., Ritthiruangdej, P., & Suphantharika, M. (2014). Optimization of hydroxypropylmethylcellulose, yeast β-glucan, and whey protein levels based on physical properties of gluten-free rice bread using response surface methodology. *LWT-Food Science and Technology, 57*, 738–748.

Kweon, M., Slade, L., & Levine, H. (2011). Solvent retention capacity (SRC) testing of wheat flour: Principles and value in predicting flour functionality in different wheat-based food processes, as well as in wheat breeding - a review. *Cereal Chemistry, 88*, 537–552.

Kwolek-Mirek, M., & Zadrag-Tecza, R. (2014). Comparison of methods used for assessing the viability and vitality of yeast cells. *FEMS Yeast Research, 14*, 1069–1079.

Le-Bail, A., Nicolitch, C., & Vuillod, C. (2010). Fermented frozen dough: Impact of pre- fermentation time and of freezing rate for a pre-fermented frozen dough on final volume of the bread. *Food and Bioprocess Technology, 3*, 197–203.

Lee, J. H., Choi, D. R., Lee, S. K., & Lee, J. K. (2004). Effect of emulsifiers on properties of the breads made by dough frozen after first fermentation. *Journal of Korean Society of Applied Biology and Chemistry, 47*, 107–112.

Lee, M. G., Lee, J. M., Chang, J. H., & Park, C. J. (2000). The effect of addition of potato starch on the frozen dough. *Korean Journal of Food and Nutrition, 13*, 403–410.

Lucas, T., Grenier, D., Bornet, M., Challois, S., & Quellec, S. (2010). Bubble growth and collapse in pre-fermented doughs during freezing, thawing and final proving. *Food Research International, 43*, 1041–1048.

Luo, W., Sun, D. W., Zhu, Z., & Wang, Q. J. (2018). Improving freeze tolerance of yeast and dough properties for enhancing frozen dough quality-A review of effective methods. *Trends in Food Science & Technology, 72*, 25–33.

Meziani, S., Jasniewski, J., Ribotta, P., Arab-Tehrany, E., Muller, J. M., Ghoul, M., et al. (2012). Influence of yeast and frozen storage on rheological, structural and microbial quality of frozen sweet dough. *Journal of Food Engineering, 109*, 538–544.

O¨ hgren, C., Fabregat, N., & Langton, M. (2016). Quality of bread baked from frozen dough–effects of rye, and sugar content, kneading time and proofing profile. *LWT-Food Science and Technology, 68*, 626–633.

Park, E. Y., Jang, S. B., & Lim, S. T. (2016). Effect of fructo-oligosaccharide and isomalto- oligosaccharide addition on baking quality of frozen dough. *Food Chemistry,*

213, 157–162.

Park, B. J., Shin, E. H., Kim, S. H., & Park, C. S. (2006). Influence of emulsifiers and α-amylases on the quality of frozen dough. *Korean Journal of Food Science and Technology*, *38*, 59–67.

Ra¨sa¨nen, J., H¨arko¨nen, H., & Autio, K. (1995). Freeze-thaw stability of prefermented frozen lean wheat doughs: Effect of flour quality and fermentation time. *Cereal Chemistry*, *72*, 637–642.

Ra¨sa¨nen, J., Laurikainen, T., & Autio, K. (1997). Fermentation stability and pore size distribution of frozen prefermented lean wheat doughs. *Cereal Chemistry*, *74*, 56–62.

Ribotta, P. D., Leo´n, A. E., & An˜o´n, M. C. (2003). Effects of freezing in frozen dough. *Cereal Chemistry*, *80*, 454–458.

Sharadanant, R., & Khan, K. (2003a). Effect of hydrophilic gums on frozen dough. I. Dough quality. *Cereal Chemistry*, *80*, 764–772.

Sharadanant, R., & Khan, K. (2003b). Effect of hydrophilic gums on frozen dough. II. Bread characteristics. *Cereal Chemistry*, *80*, 773–780.

Steffolani, M. E., Ribotta, P. D., Perez, G. T., Puppo, M. C., & Leo´n, A. E. (2012). Use of enzymes to minimize dough freezing damage. *Food and Bioprocess Technology*, *5*, 2242–2255.

Suwannarong, S., Wongsagonsup, R., Luangpituksa, P., Wongkongkatep, J., Somboonpanyakul, P., & Suphantharika, M. (2019). Optimization of yeast β-glucan and additional water levels, and chilled storage time on characteristics of chilled bread using response surface methodology. *Journal of Food Measurement and Characterization*, *13*, 1683–1694.

Wang, P., Chen, H., Mohanad, B., Xu, L., Ning, Y., Xu, J., et al. (2014). Effect of frozen storage on physico-chemistry of wheat gluten proteins: Studies on gluten-, glutenin- and gliadin-rich fractions. *Food Hydrocolloids*, *39*, 187–194.Wang, P., Jin, Z., & Xu, X. (2015). Physicochemical alterations of wheat gluten proteins upon dough formation and frozen storage – a review from gluten, glutenin and gliadin perspectives. *Trends in Food Science & Technology*, *46*, 189–198.

Wang, P., Yang, R., Gu, Z., & Xu, X. (2017). Comparative study on the freeze stability of yeast and chemical leavened steamed bread dough. *Food Chemistry, 221*, 482–488