

發酵大豆乳清豆腐的風味與品質：製程階段與加工 方法之影響

梁勻榕

2025/09/20

大綱

- 一、前言
- 二、材料與方法
- 三、結果與討論
- 四、結論

摘要

評估發酵大豆乳清豆腐的三種不同加工方法(過濾後煮沸法 FBM、煮沸後過濾法 BEM 以及重複煮沸過濾法 RBFM) 的品質、營養和風味的影響。從豆腐的感官特性、理化特性、質地特徵、結構、異黃酮和風味成分等六項指標進行評估，結果有三：(1)RBFM 的豆腐在產量、保水能力和蛋白質含量表現最佳。(2)三組中，BFM 和 RBFM 在質地、結構和感官特性上更勝一籌。(3)BFM 和 RBFM 的異黃酮和豆味的揮發性化合物(1-己醇、(E)-2-己烯醇)顯著提升，而己醛含量則顯著降低。總結而言，RBFM 方法生產的豆腐品質最好，可以為商業級豆腐的生產提供理論及技術支持。

關鍵字：豆腐、品質、風味、理化特性及加工技術

參考文獻

- Cao, F.-H., Li, X.-J., Luo, S.-Z., Mu, D.-D., Jiang, S.-T., Zhao, Y.-Y., Zheng, Z., & Zhong, X.-Y. (2017). Effects of organic acid coagulants on the physical properties of and chemical interactions in tofu. *Food Science and Technology*, 85, 58-65.
- Chang, S., Gillen, A. M., Meng, S., & Zhang, Y. (2016). Protein and quality analyses of accessions from the USDA soybean germplasm collection for tofu production. *Food Chemistry*, 213, 31-39.
- Chang, S. K. C., Guo, S., Liu, Z., & Zhang, Y. (2012). Off-Flavor Related Volatiles in Soymilk As Affected by Soybean Variety, Grinding, and Heat-Processing Methods. *Journal of Agricultural and Food Chemistry*, 60(30), 7457-7462.

- 1 Chang, S. K. C., & Xu, B. (2008). Total Phenolics, Phenolic Acids, Isoflavones, and
2 Anthocyanins and Antioxidant Properties of Yellow and Black Soybeans As Affected
3 by Thermal Processing. *Journal of Agricultural and Food Chemistry*, 56(16), 7165-
4 7175.
- 5 Chen, B., Lan, Y., Ohm, J.-B., Rao, J., & Xu, M. (2019). Solid dispersion-based spray-drying
6 improves solubility and mitigates beany flavour of pea protein isolate. *Food Chemistry*,
7 278, 665-673.
- 8 Chen, F.-l., Guan, H.-n., Fu, Y., Liu, L.-l., Liu, Y., Shi, Y.-g., Yang, Y., Zhang, C.-y., Zhang, N.,
9 & Zhu, P.-y. (2021). HS-GC-IMS with PCA to analyze volatile flavor compounds
10 across different production stages of fermented soybean whey tofu. *Food Chemistry*,
11 346, 128880.
- 12 Chen, F. l., Guan, H. n., Liu, L. l., Piekoszewski, W., Shi, Y. g., Wang, B., Yang, Y., Zhang, N.,
13 Zeng, J. h., & Zhu, X. q. (2020). Influence of four different coagulants on the
14 physicochemical properties, textural characteristics and flavour of tofu. *International*
15 *Journal of Food Science & Technology*, 55(3), 1218-1229.
- 16 Chen, H., Li, B., Lin, D., Liu, J., Li, L., Li, S., Liu, W., Liu, Y., Qin, W., Wang, C., Yang, W.,
17 & Zhang, Q. (2018). Research progress in tofu processing: From raw materials to
18 processing conditions. *Critical Reviews in Food Science and Nutrition*, 58(9), 1448-
19 1467.
- 20 Chen, J., Hu, Y., Liu, J., Pu, C., Yu, H., Wang, Y., & Zhang, W. (2015). Relationship between
21 nutritional components and texture profile of tofu from two preparation methods. *Food*
22 *Science*, 36(19), 49-54.
- 23 Chi, J., Ding, N., Ji, Y. D., Liu, L., Yin, S. N., & Yuan, J. M. (2020). Dual-energy CT to
24 differentiate gallbladder polyps: cholesterol versus adenomatous. *Acta Radiologica*,
25 62(2), 147-154.
- 26 Chiba, K., Toda, K., & Ono, T. (2007). Effect of components extracted from okara on the
27 physicochemical properties of soymilk and tofu texture. *Journal of Food Science*, 72(2),
28 C108-C113.
- 29 Choi, S.-G., Chun, J., Gul, K., Kang, S.-W., Kerr, W. L., Kim, A.-N., Lee, K.-Y., & Rahman,
30 M. S. (2019). Quality characteristics and storage stability of low-fat tofu prepared with
31 defatted soy flours treated by supercritical-CO₂ and hexane. *Food Science and*
32 *Technology*, 100, 237-243.
- 33 Coupland, J., Elias, R., Euston, S., Hayes, J., & Tenney, K. (2017). Binding of Caffeine and
34 Quinine by Whey Protein and the Effect on Bitterness. *Journal of Food Science*, 82(2),
35 509-516.
- 36 Dai, Y.-Q., Dong, J.-J., Liu, X.-L., Wu, H., Xia, X.-D., & Zhou, J.-Z. (2021). Effects of lactic
37 acid bacteria fermented yellow whey on the protein coagulation and isoflavones
38 distribution in soymilk. *Food Chemistry*, 334, 127484.

- 1 Dend, Y.-x., Fan, L., Liu, H.-y., Mo, X., Shen, G.-x., Wu, J., Xie, C.-p., & Zhao, L.-z. (2020).
2 Study on the influence of different pulping processes on the quality of soymilk. *Food*
3 *and Fermentation Industries*.
- 4 Dong, H., Hu, B., Li, K., Li, L., Qin, W., Wang, C., Wu, D., Yang, W., & Zhang, Q. (2021).
5 Influence of soybean protein isolate-dextran conjugates on the characteristics of
6 glucono- δ -lactone-induced tofu. *Food Science and Technology*, 139, 110588.
- 7 Eun, J.-B., Kim, P.-H., & Zhao, C.-C. (2020). Influence of high-intensity ultrasound application
8 on the physicochemical properties, isoflavone composition, and antioxidant activity of
9 tofu whey. *Food Science and Technology*, 117, 108618.
- 10 Guo, S. T., Li, X., Lv, Y. C., Song, H. L., & Wu, L. (2011). Influence of blanching and grinding
11 process with hot water on beany and non-beany flavor in soymilk. *Journal of Food*
12 *Science*, 76(1), S20-25.
- 13 Guo, Y., Hu, H., Liu, H., & Wang, Q. (2018). A novel process for peanut tofu gel: Its texture,
14 microstructure and protein behavioral changes affected by processing conditions. *Food*
15 *Science and Technology*, 96, 140-146.
- 16 He, W., Huang, Z., Liu, H., Zhao, L., & Zhou, X. (2021). Processing technology optimization
17 for tofu curded by fermented yellow whey using response surface methodology. *Food*
18 *Science & Nutrition*, 9(7), 3701-3711.
- 19 Hsia, S.-Y., Hsiao, Y.-H., Hsieh, J.-F., & Li, W.-T. (2016). Aggregation of soy protein-
20 isoflavone complexes and gel formation induced by glucono- δ -lactone in soymilk.
21 *Scientific Reports*, 6(1), 35718.
- 22 Hsiao, Y.-H., Hsieh, J.-F., Li, W.-T., & Yu, C.-J. (2015). Coagulation of β -conglycinin, glycinin
23 and isoflavones induced by calcium chloride in soymilk. *Scientific Reports*, 5(1), 13018.
- 24 James, A. T., & Yang, A. (2016). Interactions of protein content and globulin subunit
25 composition of soybean proteins in relation to tofu gel properties. *Food Chemistry*, 194,
26 284-289.
- 27 Li, A., Li, T., Ma, L., Jiang, Z., Sun, D., & Zhang, F. (2019). Effect of selective thermal
28 denaturation and glycosylation on the textural properties and microstructure of
29 vegetable tofu. *Journal of Food Process Engineering*, 42(3), e13001.
- 30 Qu, W.-Y., Sun, B.-G., Tian, D.-T., & Yu, A.-N. (2008). Analysis of volatile compounds in
31 traditional smoke-cured bacon(CSCB) with different fiber coatings using SPME. *Food*
32 *Chemistry*, 110(1), 233-238.
- 33 Rosset, M., Prudencio, S. H., & Beléia, A. D. P. (2012). Viscozyme L action on soy slurry
34 affects carbohydrates and antioxidant properties of silken tofu. *Food Science and*
35 *Technology International*, 18(6), 531-538.
- 36 Shi, Y.-g., Yang, Y., Piekoszewski, W., Zeng, J.-h., Guan, H.-n., Wang, B., Liu, L.-l., Zhu, X.-
37 q., Chen, F.-l., & Zhang, N. (2019). Influence of four different coagulants on the

1 physicochemical properties, textural characteristics and flavour of tofu. *International*
2 *Journal of Food Science and Technology*, 55(3), 1218-1229.

3 Zuo, F., Chen, Z., Shi, X., Wang, R., & Guo, S. (2016). Yield and textural properties of tofu as
4 affected by soymilk coagulation prepared by a high-temperature pressure cooking
5 process. *Food Chemistry*, 213, 561-566.

6