Original Article
Food Science and Technology

ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)

DOI: https://doi.org/10.1590/fst.87622

Changes in ramen dough and constituent proteins during production by hand

Beibei TIAN[1], Jie CHEN[1*], Yingguo LÜ[1]

Abstract

In this study, tensile strength, slicing, and infrared characteristics were evaluated to determine the changes in ramen dough and constituent proteins during production by hand. The results showed that two variables played important roles during the ramen-making process: the frequency of ramen agent additions and the method of ramen making. After two additions of the ramen agent to the dough, the tensile strength increased to the maximum value. Moreover, the ordered secondary structure of the protein improved, and the starch granules and protein molecules were arranged in an orderly fashion.

Keywords: ramen; protein; infrared spectrum; slicing.

Practical Application: When the dough was pulled moderately during the ramen-making process, the extensibility of dough strengthened as well as the content of β-sheet, and the protein network which embedded starch granules became orderly. The results of this study provide theoretical guidance for the industrial production of Ramen.

1 Introduction

Chinese cuisine, including flour-based products, has historically been very popular around the world. Chinese cuisine offers a variety of handmade noodles such as ramen, stewed noodles, and Dan D`an noodles among others. Ramen was one of the most popular traditional noodle varieties in China. Raman tastes special with pliable, elastic noodle and delicious soup. Ramen is often served with beef soup, hot pepper oil, carrot slices, parsley, and garlic as a unique snack. In recent years, the ramen market has developed rapidly, and ramen has become a major brand of fast food in China, as well as in Europe, the United States, and Southeast Asia.

Ramen production is very complicated as well. The process of making ramen involves artificial kneading, tearing, kneading, twisting, and stretching. As the production of ramen is mainly completed by hand stretching, ramen is also called hand-extended noodle. The shape and quality of the noodles depend on the chef's skills. According to some reports, a piece of dough can be pulled out to 1024 single-strand noodles, as thin as 0.008 mm in diameter each, even can be called wheat flour fibers (Figure 1). The extensibility of ramen is an important index in the evaluation of noodle quality. Ramen agents (which was a commercially available quality improve additives for ramen. with penghui as the main ingredients) may play an important role in modifying ramen extensibility. The main effects of ramen agents relate to the flavor, color, and structure of the dough, and may increase the dough's gluten content and elasticity, which might have a favorable effect on the taste and texture of noodles (Wang et al., 2021).

Cao etc. have shown that the extensibility and viscoelasticity of dough are primarily determined by the content and structure of wheat proteins (Cao et al., 2021). Notably, gliadin and glutenin have been shown to affect dough extensibility and viscoelasticity. Wheat gluten and gliadin are responsible for the rheological properties of dough (Guo et al., 2021; Li et al., 2020; Wang et al., 2022). The extensibility of Ramen dough needs to be especially strong. Li Rui etc. studied the effect of ramen agents and found that ramen agents can significantly alter the dough extensibility (Obadi et al., 2021a). However, the mechanism of the change is not clear and rarely reported. In this study, the structure changes of the dough and the protein molecules during Ramen production were investigated. In order to reveal the principle of ramen agents and the change of dough extensibility.

2 Materials and methods

2.1 Material and reagents

Brilliant green solution (Fluka), iodine, potassium iodide, and potassium bromide were analytically pure. High-gluten flour, salt, ramen agent (LiSi Food science and Technology Co, Ltd) was obtained from commercial sources.

2.2 Equipment

A WQF-510 FT-IR spectrometer (Beijing Ruili analytical instrument company), KD-1508A rotary microtome (Zhejiang Jinhua Cody instrument equipment Co., Ltd), BT-1600 particle size analyzer (Beijing Baxter technology development Co., Ltd), TA-XT Plus texture analyzer (STABLE MICRO SYSTEM Co., Ltd), FD-1A-50 vacuum freeze dryer (Beijing Boyikang Laboratory Instruments Co., Ltd.), BCD-241 refrigerator (Henan XinFei Electric Co., Ltd.), and FW-100 high-speed grinder (Beijing ZhongXingweiye Instrument Co., Ltd) were used in this study.

Received 12 Jul., 2022
Accepted 22 Sept., 2022
[1] College of Food Science and Technology, Henan University of Technology, Zhengzhou, China
*Corresponding author: 15703887555@163.com

Figure 1. Ramen making method.

2.3 Methods

Ramen production

The ramen recipe included the following ingredients: high-gluten flour 1 kg, water 50%, ramen agent 0.6%, salt 1% (Obadi et al., 2022).

The ramen production included the following seven steps: dough making-proofing-tear (Sample 1); knead (Sample 2); twist (Sample 3); stretch-add ramen agent and tear, knead, twist (Sample 4); stretch-add ramen agent and tear, knead, twist (Sample 5); stretch-add ramen agent and tear, knead, twist (Sample 6); stretch-make the dough into the ramen (Sample 7).

The specific production steps were as follows: after the salt and ramen agent were completely dissolved in water, they were poured into the flour (1 kg). The dough-making machine was used to make dough for 10 min. The dough was placed in a closed environment at room temperature. After proofing for 15 min, the dough was kneaded (torn, kneaded, twisted, and stretched). After adding the liquid ramen agent (concentration of 0.6%, 5 mL) into the dough three times, the above steps were repeated to knead the dough further. The dough was formed into a round shape and was the stretched to form the ramen (Yeoh et al., 2020).

After the aforementioned seven steps were carried out, a 200 g portion was removed from the dough each time after mixing, and the samples were numbered 1-7.

Dough tensile test

Ten grams of dough was used for the tensile test. The dough was formed into rough strips and placed on the mold groove. Another plate was placed on top of the dough and was pressed until the two plates came into full contact. The mold was clamped and a scraper was used to remove the excess dough. Next, the mold was opened, the top plate was moved backward, and the dough strip was removed by taking special care not to alter its length or shape. The texture analyzer was immediately used to conduct the dough tensile test. The dough-stretching curve was obtained until the dough strip broke. Three parallel tests were conducted and treatment parameters using the average method. The experimental parameters were as follows: A/KIE probe, pre-test speed: 2.0 mm/s, test speed: 2.0 mm/s, post-test speed: 10 mm/s, distance: 100 mm, and trigger force: 5 g.

Infrared test

Powdered samples for the infrared tests were obtained as follows: 100 g of dough was used to product wet gluten according GBT5506.2-2008. The wet gluten was placed in the refrigerator and frozen for 2 h. Next, the frozen wet gluten was placed into the vacuum freeze dryer for 2 d. Finally, the dry gluten was milled and separated over a 200-mesh sieve.

About 400 mg of potassium bromide and 1-2 mg of the sample were placed in an agate mortar and were grinded. The tablet machine was used to press an appropriate amount of the mixture to a thin, transparent slice. A Fourier transform infrared spectrometer was used to scan the wavenumber range from 400-4000 cm^{-1}. Peakfit v4.12 was used to analyze the region from 1600-1700 cm^{-1}. Following the baseline correction, Gaussian (Gaussian) deconvolution was carried out. The second derivative was subsequently fitted. Finally, the percentages of the secondary structures were calculated and according the resulting graph of each sub-peak area.

Slice test

Fifty grams of dough was cut into 3 cm × 2 cm × 1 cm pieces, which were placed in the refrigerator for 2 h. The frozen dough was used in the slice test. The frozen dough slicer was used to cut the frozen dough into a 15 μm-thick sheet, which was subsequently flattened on a glass slide. The dough was dyed with a 0.1% aqueous solution of brilliant green for 1 min, and then with 1/5 concentration Lugol's iodine (I_2 0.33% (m/v); 0.67% KI (m/v)) for 1 min (An et al., 2022; Obadi et al., 2021b). A filter paper was used to remove the excess stain, cover the glass on it. The particle size was subsequently determined. After the focus was adjusted, the sample was photographed with a camera.

3 Results and analysis

3.1 Changes in dough stretching distance and pull force

Figures 2, 3 show that the glutenin in fresh dough was extended into a linear peptide chain structure, but is difficult to produce intermolecular entanglement slide. At this point, regardless of the flour quality, the dough extensibility was small and the laminar flow resistance was large. After curing, the wheat gluten molecules were aligned linearly and the entanglements were greatly reduced; the dough exhibited good extension bombs balance (Mohammed & Xu, 2020). Join the ramen agents and continue to knead the dough, the stretching distance increased and then decreased; the pull force decreased and then increased upon addition of the ramen agent, because the molecular structure of the protein was altered, thus making the dough more resilient and more pull-resistant than before, the elongation was better. If excess ramen agent was added, the structure of the gluten was damaged and the toughness and extensibility of the dough decreased.

3.2 Changes in the protein secondary structure content of the dough

With increased amounts of the ramen agent, the protein secondary structure content of the dough changed significantly (Table 1). In the infrared spectra, the region between 1650-1670 cm^{-1} corresponds to the α-helix, 1610-1640 cm^{-1} corresponds to β-fold, 1680-1700 cm^{-1} corresponds to β-corner, and 1640-1650 cm^{-1} corresponds to random coil (Sun et al., 2021; Yang et al., 2020). Table 1 illustrates that the β-fold content increased and then decreased, while the α-helix content decreased and then increased. The random coil content increased, decreased, and finally increased. However, the relative β-corner content remained unchanged. The contents of the four structures did not change during the first three processes. However, after the ramen agent was added, the β-sheet and random coil content increased significantly and the α-helix content decreased. This phenomenon may due to production by hand as the protein molecules were arranged more regularly. Upon adding the ramen agent, a second time, the β-fold content reached a peak. At this time, the protein molecules were ordered and the dough became suitable for the production of ramen. However, adding excess ramen agent will disrupt the protein structure and make it disorganized.

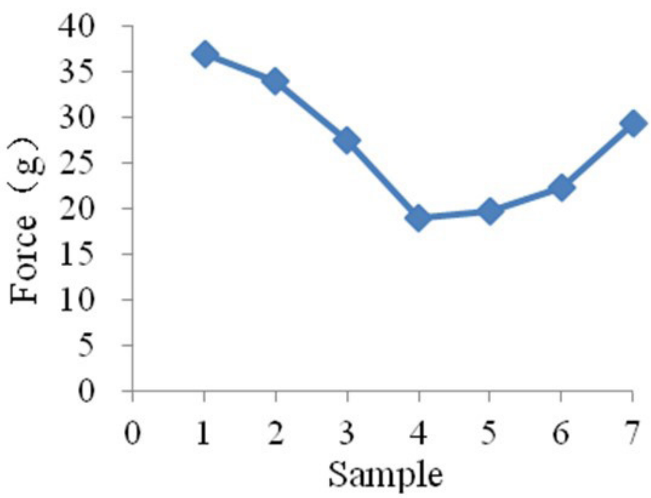

Figure 2. The change in dough pulling force during different steps.

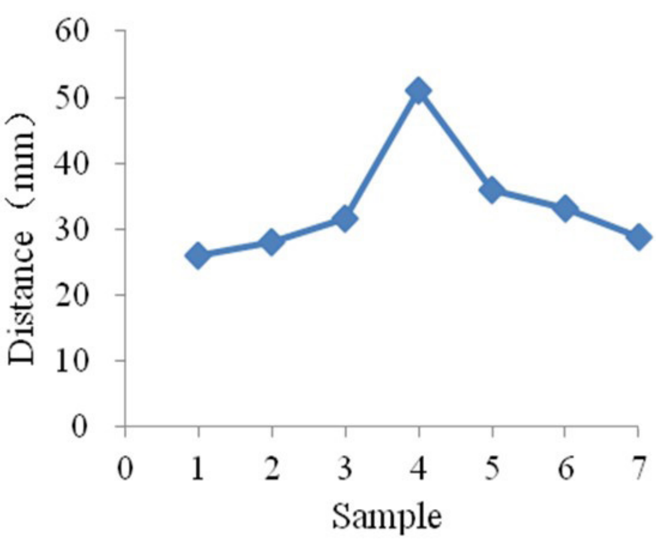

Figure 3. The change of dough stretching distance though different steps.

Table 1. The content of protein secondary structure content in dough.

sample	β-fold /%	random coil /%	α-helix /%	β-corner /%
1	21.3638	19.8619	46.9552	11.6941
2	22.1903	19.15	48.316	10.3431
3	23.5027	19.6147	46.3763	10.5064
4	36.7906	30.7945	20.3311	12.0838
5	44.2853	29.1556	16.5213	10.0375
6	43.2362	27.0159	19.4219	10.326
7	35.8354	32.4728	21.598	10.0939

3.3 Dough slice research in different steps

Images of the different steps are shown in Figure 4. The proteins appeared green, while the starch granules appeared purple and brown-black. Among them, amylose had less iodine than amylopectin, thus amylase appeared purple and amylopectin appeared brown-black (Cheng et al., 2021; Du et al., 2021). In dough, starch granules were wrapped inside the proteins, but they were not distributed. After proofing, the protein and starch exhibited a uniform distribution and were in a relatively stable state. After the first handmade, the proteins gradually formed a long strip, but the starch granules only changed slightly. After the first addition of the ramen agent, the proteins formed a distinct elongated structure, and the starch granules formed aligned strips. After the second addition of the ramen agent, the proteins formed a regular strip, and the starch granules were wrapped inside the proteins and were arranged according to the network structure of the proteins. After the third addition of the ramen agent, the elongated protein structure was destroyed, and the starch granules became less ordered. When the dough was made into ramen, the protein structure was significantly altered and the starch granules were disordered.

4 Discussion

In this study, three different methods were used to evaluate handmade ramen dough during various stages of production; the results complemented each other. During the dough making, proofing, and first manual processing time, the dough properties did not change significantly. Upon the first addition of the ramen agent, the dough became pull-resistant. In terms of the molecular structure, the number of effective molecular structure tended to increase. The dough-slice results showed that the protein molecules became elongated as well. After the second addition of the ramen agent to the dough, the protein molecules and starch granules appeared in an ordered arrangement; the ordered structure of the protein secondary structure was maximized. After adding

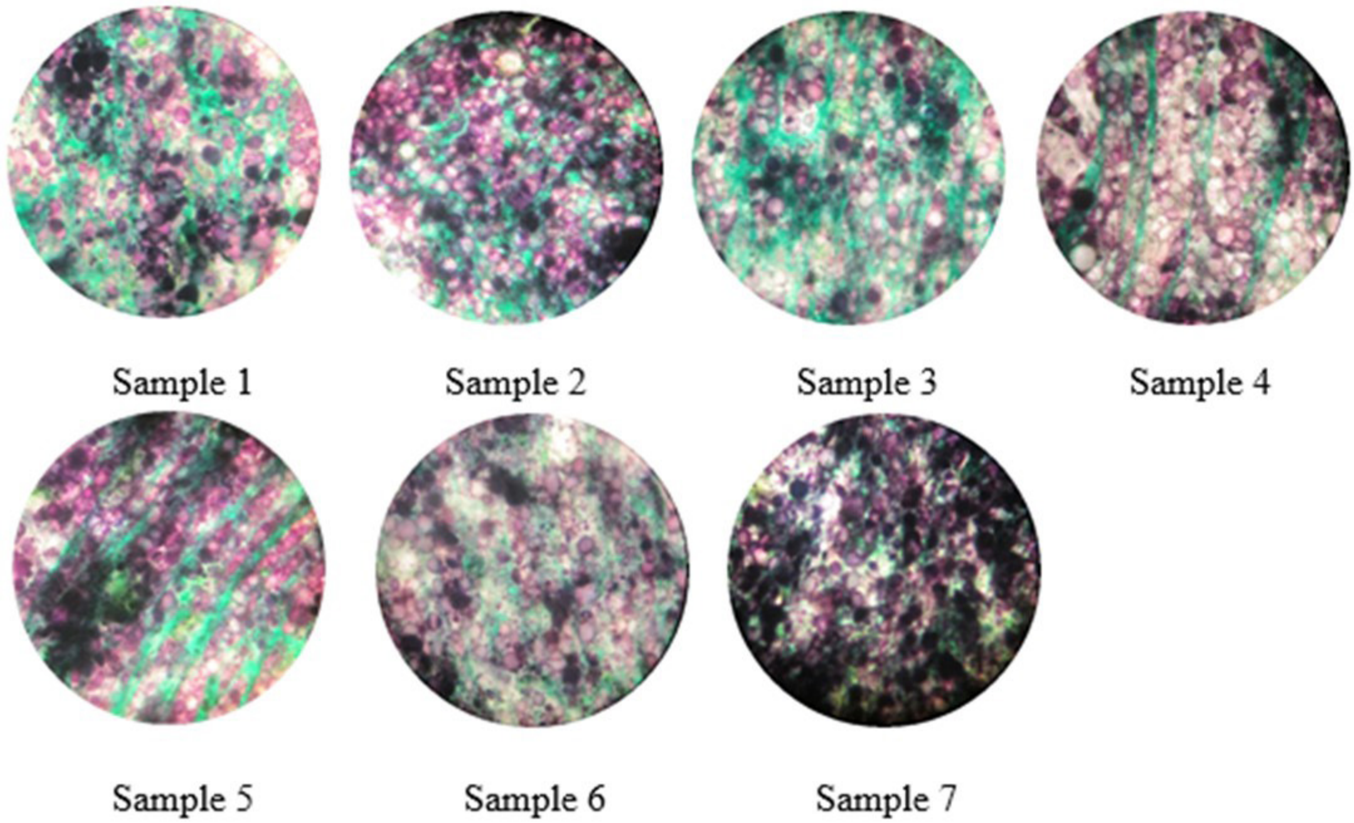

Figure 4. Protein network in ramen dough during process.

the ramen agent a third time, the original protein distribution was disrupted; the percentage of the ordered structure decreased, as did the dough pull-resistance. The amount of added ramen agent is critical to prepare the best dough.

5 Conclusion

Two variables played important roles during the ramen-making process: the frequency of ramen agent additions and the method of ramen making. After two additions of the ramen agent to the dough, the tensile strength increased to the maximum value. Moreover, the ordered secondary structure of the protein improved, and the starch granules and protein molecules were arranged in an orderly fashion. When the dough was pulled moderately, the extensibility of dough strengthened as well as the content of β-sheet, and the protein network which embedded starch granules became orderly. The results of this study provide theoretical guidance for the industrial production of Ramen.

Funding

This work was supported by Natural Science Innovation Fund Support Plan of Henan University of Technology (2020ZKCJ13).

References

An, D., Li, H., Li, DS., Zhang, D., Huang, Y., Obadi, M., & Xu, B. (2022). The relation between wheat starch properties and noodle springiness: from the view of microstructure quantitative analysis of gluten-based network. *Food Chemistry*, 393, 133396. https://doi.org/10.1016/j.foodchem.2022.133396.

Cao, Z. B., Yu, C., Yang, Z., Xing, J. J., Guo, X. N., & Zhu, K. X. (2021). Impact of gluten quality on textural stability of cooked noodles and the underlying mechanism. *Food Hydrocolloids*, 119, 106842. http://dx.doi.org/10.1016/j.foodhyd.2021.106842.

Cheng, W., Sun, Y. J., Xia, X. Z., Yang, L. Z., Fan, M. C., Li, Y., Wang, L., & Qian, H. F. (2021). Effects of ll-amylase treatment conditions on the gelatinization and retrogradation characteristics of wheat starch. *Food Hydrocolloids*, 124(Pt B), 107286. https://doi.org/10.1016/j.foodhyd.2021.107286.

Du, J., Li, Q. Q., Obadi, M., Qi, Y. J., Liu, S. Y., An, D., Zhou, X. L., Zhang, D. S., & Xu, B. (2021). Quality evaluation systems and methods of the whole making process of asian noodles: a review. *Food Reviews International*, 2013871. http://dx.doi.org/10.1080/87559129.2021.2013871.

Guo, J., Wang, F., Zhang, Z., Wu, D., & Bao, J. (2021). Characterization of gluten proteins in different parts of wheat grain and their effects on the textural quality of steamed bread. *Journal of Cereal Science*, 102, 103368. http://dx.doi.org/10.1016/j.jcs.2021.103368.

Li, S., Liu, Y., Tong, J., Yu, L., Ding, M., Zhang, Z., Rehman, A. U., Majzoobi, M., Wang, Z., & Gao, X. (2020). The overexpression of high-molecular-weight glutenin subunit bx7 improves the dough rheological properties by altering secondary and micro- structures of wheat gluten. *Food Research International*, 130, 108914. http://dx.doi.org/10.1016/j.foodres.2019.108914. PMid:32156364.

Mohammed, O., & Xu, B. (2020). Review on the physicochemical properties, modifications, and applications of starches and its common modified forms used in noodle products. *Food Hydrocolloids*, 112, 106286.

Obadi, M., Zhang, J., & He, Z. (2021a). A review of recent advances and techniques in the noodle mixing process. *LTW*, 154, 112680. https://doi.org/10.1016/j.lwt.2021.112680.

Obadi, M., Zhang, J., Shi, Y., & Xu, B. (2021b). Factors affecting frozen cooked noodle quality: a review. *Trends in Food Science & Technology*, 109(8), 662-673. http://dx.doi.org/10.1016/j.tifs.2021.01.033.

Obadi, M., Zhang, J., & Xu, B. (2022). The role of inorganic salts in dough properties and noodle quality—A review. *Food Research International*, 157, 111278. http://dx.doi.org/10.1016/j.foodres.2022.111278. PMid:35761589.

Sun, J., Chen, M., Hou, X. X., Li, T. T., Qian, H. F., Zhang, H., Li, Y., Qi, X. G., & Wang, L. (2021). Effect of phosphate salts on the gluten network structure and quality of wheat noodles. *Food Chemistry*, 358, 129895. http://dx.doi.org/10.1016/j.foodchem.2021.129895. PMid:33933957.

Wang, F., Chao, H. M., Xu, Z. H., Wu, Y., Sun, L. Q., & Wang, N. F. (2022). Bran characteristics impact the whole wheat noodle quality. *Food Science and Technology (Campinas)*, 42, e29322. http://dx.doi.org/10.1590/fst.29322.

Wang, J. R., Guo, X. N., Yang, Z., Xing, J.-J., & Zhu, K.-X. (2021). Insight into the relationship between quality characteristics and major chemical components of chinese traditional hand-stretched dried noodles: a comparative study. *Food and Bioprocess Technology*, 14(5), 1-11. http://dx.doi.org/10.1007/s11947-021-02618-x.

Yang, S., Zheng, M., Li, S., Xiao, Y., Zhou, Q., & Liu, J. (2020). Preparation of glycosylated hydrolysate by liquid fermentation with Cordyceps militaris and characterization of its functional properties. *Food Science and Technology (Campinas)*, 40(suppl 1), 42-50. http://dx.doi.org/10.1590/fst.37518.

Yeoh, S. Y., Lubowa, M., Tan, T. C., Murad, M., & Mat Easa, A. (2020). The use of salt-coating to improve textural, mechanical, cooking and sensory properties of air-dried yellow alkaline noodles. *Food Chemistry*, 333, 127425. http://dx.doi.org/10.1016/j.foodchem.2020.127425. PMid:32683254.