Effect of Organic-Acid-Soaking on the Extension of the Shelf Life of Fresh Noodles

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ABSTRACT

Fresh Noodle (FN), an instant noodle without oil-fried process, was healthier and more nutritious than fried instant noodle. But the main problem of Fresh Noodle (FN) is preservation because of their high-content water content 60%. According to trials, by the processes of steaming and then acid soaking, the quality of Fresh Noodle (FN) can be solved well. The aim of this study was to investigate the influence of the different organic acids on FN shelf-life and sensory evaluation and the impact of processing parameters (acid solution acidity, time and temperature of acid soaking) on FN acidity. The results showed that the organic acids mixture (lactic acid: malic acid: citric acid = 2.0:0.25:0.25) can extend FN shelf-life significantly and the optimum acid soaking process can also resolve the problem about the storage of Fresh Noodle (FN) when three process parameters (acid solution acidity, acid-soaking time and temperature) were from 1.55-1.65% from 35-45 sec and from 25-35°C, respectively.

Key words: Fresh noodle, organic acid, acid soaking, shelf-life, sensory evaluation

INTRODUCTION

Noodles originated from China about 2000 years ago. They have not only been the popular main food of Chinese people all over the country, but are also widely propagated through the whole of Asia, Europe, America and even throughout the world.

Keep-fried instant noodles are widely preferred by consumers due to their excellent flavor, convenience and ease of preparation (Wu *et al*., 1998). However, like other deep fried products, the high residual oil content, the presence of oil-derived compounds in deep-fried products and their potential health impact has raised concerns (Saguy and Dana, 2003). Excessive lipid consumption is correlated with obesity, cardiovascular disease and other health disorders and pressure from governmental and consumer groups to restrict the level of lipids in foods has increased (Roberts, 1989). The high oil uptake by noodles during frying also increased production costs and adversely affects shelf-life (Moss *et al*., 1987). Besides, the high oil content is often not necessary for product quality (Liu *et al*., 2002, 2003; Lu, 2003).

Now noodles are main food, second only to breads all over the world (Zhu, 1996). Along with the development of the modern food industry, nutritive and functional foods and drinks have been developed further and the world food market has become more and more diversified. Therefore, it is an inevitable step to study and develop various forms of novel nutritive noodles.

A Fresh Noodle (FN), the fourth instant noodle was an instant noodle without oil-fried process. Comparing with oil-fried noodle, Fresh Noodle (FN) has many differences in some factors such as usage of raw materials, processes, quality control and so on. In addition, Fresh Noodle (FN) has many advantages in some factors such as freshness, good taste and nutrition and so on. However, the critical problem about Fresh Noodle (FN) is controlling food microorganism, that is solving its storage (extending its shelf-life) and taste (sensory evaluation).

As for conserve of Fresh Noodle (FN), there had been experiments with nature organic acid (Zhou, 1997). The objectives of this study were to investigate the effects of the different organic acids and FN acid-soaking process (three process parameters mainly: acidity of acid-solution, time and temperature of acid-soaking) on FN acidity, shelf-life and sensory evaluation.

MATERIALS AND METHODS

Materials: Wheat flour used for FN making was purchased from a local flourmill (shanghai). The flour contained 12.7% of protein and 0.45% of ash on a dry basis determined according to the AACC methods (AACC., 1995). The wet gluten of flour determined by the method of AACC 38-10 (AACC., 1995) were 30%.

Organic acids, mainly lactic acid, citric acid and malic acid was purchased from zhengzhou TianRun Plant.

Fresh Noodle (FN) preparation: The equipment used was a mixer consisting of two rolls with adjustable gab settings and a cutting roll attachment. The salt was first dissolved in the water and this solution was added to the flour over a period of 30 sec in the mixer set on speed one. Timing of mixing then began when all the liquid had been added. The mixer was set at the lowest setting (speed one) for 1 min. After that, the speed of the mixer was increased smoothly to setting two and allowed to mix for a further 5 min. After a total of 6 min mixing (1 plus 5), the resultant dough had a crumbly consistency similar to that of moist breadcrumbs. The dough was first formed into a dough sheet by a process of passing the crumbly dough through the rollers of the noodle machine. Three passes were required in order to give a uniform sheet which held together as a single dough piece. This combined sheet was allowed to rest in a glass chamber at temperature of 25 and relative humidity of 85% for 30 min. And then successively sheeted using 3.5, 2.5 and 1.5 mm roll gap settings. The final dough sheet was cut into strands using the cutting roll attachment of the noodle machine to a width of 2.5 mm. The noodle strands were then cut to 25 cm lengths before steaming in a steamer for 45 sec, boiled for 30 sec in boiling water. After boiling, the noodles were washed, respectively in running ice-water and acid-solution. The product was then allowed to sterilization, at 100°C for 30 min and place for 2 weeks prior to being placing into bags or containers for storage.

Acid-soaking of Fresh Noodles (FN): Noodle samples were acid-soaked by placing a certain amount of noodles into a chamber of acid solution (at a ratio of 1:10, one part of noodles in 10 parts of acid solution). After 30-40 sec, a strand of noodle was removed and then determined noodle acidity. The pH and acidity of FN depended upon three parameters of acid-soaking processing which were acidity of acid-solution, time and temperature of acid-soaking.

FN acidity determination

Sample preparation: Twenty grams of noodle sheets were suspended in 180 g of distilled water and homogenized for 15 min using a homogenizer. The homogenates were then centrifuged and the supernatants obtained were used as samples for pH measurement and acidity determination.

Table 1: Scoring system for Chinese white fresh noodles

Characters	Full score (minimum score)
Color	15 (3)
Appearance	10 (2)
Firmness	20 (4)
Viscoelasticity	30 (6)
Smoothness	15 (3)
Taste and flavor	10 (2)
Total	100 (20)

pH measurement and acidity determination: The pH value of supernatants was measured using pH meter. The acidity value was determined by a titration method under the following conditions: reagent, NaOH standard solution 0.001 mol L^{-1}, concentration.

Fresh Noodle (FN) sensory evaluation: The method for the sensory evaluation of Chinese white fresh noodles (Liu *et al*., 2002; Hatcher *et al*., 2004; Zhang *et al*., 2005) as shown in Table 1.

For sensory evaluation of noodle quality, eight or nine samples were tested. The sensory evaluation was performed by at least 15 trained professors who compared six parameters (i.e., color, appearance, firmness, smoothness, visco-elasticity and taste-flavor) and assigned a score to each. To adapt to standard Chinese noodle consumption style, noodles were evaluated using hot beef soup prepared by dissolving three 8 g solid soup and three 10 g sauce tablets in 1.5 L of hot water.

FN shelf-life determination: The fresh noodles obtained above was packed in plastic bags (18×12 cm) and these samples were stored at 37 and 80% relative humidity. Total viable cell numbers of fresh noodles were measured by the standard plate count method. All experiments were triplicated.
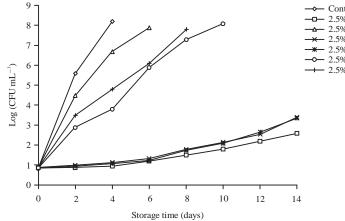
Statistical analysis: Statistics Analysis System (SAS) was employed to compute mean and standard deviation.

RESULTS AND DISCUSSION

Influence of the different organic acids on FN shelf-life and sensory evaluation: As can be seen from Fig. 1 the shelf-life of noodles without organic acids soaking was short (<4 days). When the organic acids were lactic acid alone, mixture one (lactic acid: malic acid = 2.0:0.5), mixture two (lactic acid: malic acid: citric acid = 2.0: 0.25: 0.25), FN can be stored much longer than 14 days. However, when the ratio of lactic acid of organic acid mixture was lower than 2.0, the FN shelf-life was also low. In addition, as for FN taste and flavor (Fig. 2), the FN with the mixture two (lactic acid: malic acid: citric acid = 2.0: 0.25: 0.25) was much better than the other two groups (lactic acid alone and mixture one), which the citric acid can make sour flavor become milder. The results of our study were consistent with Lin's study (Lin, 2002), but he used a single acid to extend the shelf life of wet noodles from 1 day to a week.

Influence of FN acidity on FN shelf-life and sensory evaluation: The effect of the acidity of the solution on the wet noodles was studied by Lin (2002). But few researchers had studied the effect of FN acidity on FN shelf-life and we found that the FN acidity was very important for the extension of the FN shelf-life.
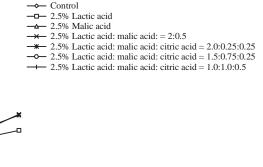
Fig. 1: Influence of different organic acids on FN shelf-life
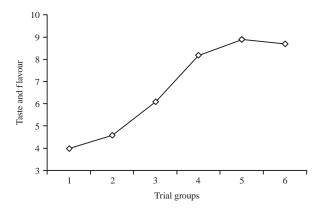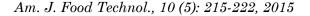

Fig. 2: Influence of different organic acids on FN taste and flavour, Results were the Mean±Standard deviation of three replications. (1) 2.5% lactic acid, (2) 2.5% malic acid, (3) 2.5% organic acids mixture (lactic acid: malic acid: = 2:0.5), (4) 2.5% organic acids mixture (lactic acid: malic acid: citric acid = 2.0:0.25:0.25), (5) 2.5% organic acids mixture (lactic acid: malic acid: citric acid = 1.5:0.75:0.25) and (6) 2.5% organic acids mixture (lactic acid: malic acid: citric acid = 1.0:1.0:0.5)

As can be seen from Fig. 3 total viable cell numbers of FN (stored for 4 days) were higher (>2 log CFU mL^{-1}) when FN acidity was lower than 0.20%. But when FN acidity was up to 0.20%, FN can be stored much longer. However, when FN acidity was more than 0.25%, FN had strong sour (sensory evaluation value was decreased sharply) that they can't be acceptable by consumers. Thus, in this experiment, the comparatively most suitable FN acidity was from 0.20-0.25%.

Effect of acid-soaking processing parameters on FN acidity: During the acid-soaking processing, the concentration of the acid-soaking solution was considered only by some researchers' studies (Ma *et al.*, 2003; Lin, 2002; Yang *et al.*, 2005; Ge *et al.*, 2001; Lai and Hwang, 2004), with little regard for the temperature of the acid-soaking solution and acid-soaking time. However, our studies found that both the temperature and time were critical process factors on acid-soaking.
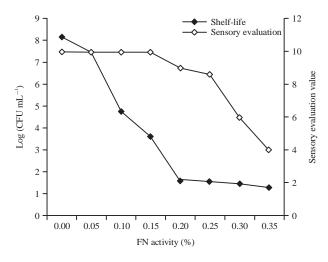
Fig. 3: Fresh noodle acidity and its relationship with shelf-life and sensory evaluation
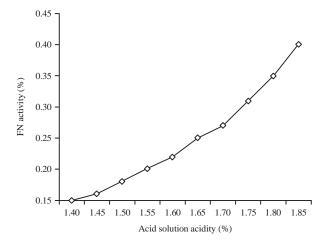

Fig. 4: Effect of acid-solution acidity on FN acidity

The data for fresh noodles (Fig. 3) indicated that FN shelf-life was related to noodle acidity greatly. A further series of experiments were designed to study the varying of noodle acidity during the acid-soaking process. These also provided information on noodle acidity mainly due to acid-soaking process which had three parameters acid solution acidity, time and temperature of acid-soaking.

As can be seen from Fig. 4, acid solution acidity was positively related to FN acidity. That is, FN acidity was increasing with the increase of the acid solution acidity. The regression equation and coefficient was shown as follows:

$$FN\ acidity\ (\%) = 0.0271 \times acid\ solution\ acidity\ (\%) + 0.1$$

$$R = 0.9812$$

And combined with Fig. 3, the optimum acid solution acidity was from 1.55-1.65%.
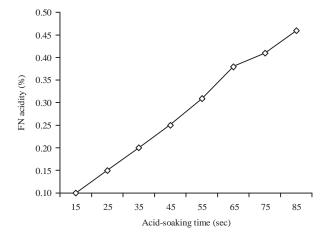
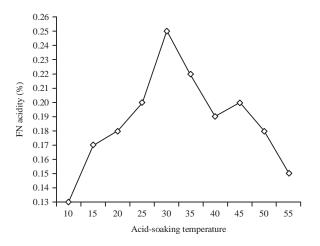Fig. 5: Effect on acid-soaking time on FN acidity

Fig. 6: Effect of acid-soaking temperature on FN acidity

As can be seen from Fig. 5, acid-soaking time was positively related to FN acidity. That is, FN acidity was increasing with the increase of acid-soaking time. The regression equation and coefficient was shown as follows:

$$FN\ acidity\ (\%) = 0.0526 \times acid\text{-}soaking\ time\ (sec) + 0.0457$$

$$R = 0.996$$

And combined with Fig. 3, the optimum time of acid-soaking was from 35-45 sec.

As can be seen from Fig. 6, acid-soaking temperature was positively related to FN acidity when it was lower than 30°C. However, FN acidity was decreasing sharply with the increasing of temperature of acid-soaking (from 30-55°C). We can conclude that the acid solution was the mixture of organic acids which were volatile easily when the temperature of acid-soaking was up to a certain degree and combined with Fig. 3, the optimum temperature of acid-soaking was from 25-35°C.

Table 2: Influence of acid-soaking processing on FN acidity, shelf-life and sensory evaluation

Parameters	FN acidity	FN shelf-life	FN sensory evaluation
Acid solution acidity	0.0079**	24.5667**	0.3061
Acid-soaking time	0.0017	4.2962	10.6311*
Acid-soaking temperature	0.0007	1.0000	1.9516

*Significance at 5% probability level, **Significance at 1% probability level

Influence of acid-soaking processing on FN shelf-life and sensory evaluation: The aim of this study has been to investigate the influence of FN acidity on FN shelf-life and sensory evaluation and the impact of processing parameters on FN acidity.

The influence of acid-soaking processing on FN acidity, shelf-life and sensory evaluation was shown in Table 2. Acid solution acidity, which was one of the acid-soaking processing parameters, showed significant difference in FN acidity ($p < 0.05$) and with FN shelf-life ($p < 0.05$), but no significant difference ($p > 0.01$) in FN sensory evaluation. And acid-soaking time showed significant difference in FN sensory evaluation ($p < 0.01$), but no significant difference ($p > 0.01$) in FN acidity and shelf-life. However, there was not a significant difference ($p > 0.01$) for acid-soaking temperature. According to Table 2, the sequence of important parameters of acid-soaking processing was acid solution acidity and then acid-soaking time and finally acid-soaking temperature.

CONCLUSION

According to trials, by the process of acid soaking, the quality of Fresh Noodle (FN) can be solved well. The study had investigated the influence of different organic acids on FN shelf-life and taste. The results showed that the three organic acids formula of 2.5% lactic acid alone, 2.5% organic acids mixture (lactic acid: malic acid: = 2:0.5) and 2.5% organic acids mixture (lactic acid: malic acid: citric acid = 2.0:0.25:0.25) can extend FN shelf-life significantly, but the third formula with citric acid had much better taste and flavor than the other two formulas.

The study had also investigated the influence of FN acidity on FN shelf-life and sensory evaluation and the impact of processing parameters (acid solution acidity, time and temperature of acid soaking) on FN acidity. The results showed that when FN acidity was up to 0.20, FN shelf-life can be solved well. What' more, the optimum acid soaking process can also resolve the problem about the storage of Fresh Noodle (FN) when three process parameters (acid solution acidity, acid-soaking time and temperature) were from 1.55-1.65%, from 35-45 sec and from 25-35°C, respectively.

Throughout these experiments the results indicated that the extending of FN shelf-life depended on the selective of organic acids and the FN acidity which resulted from the process of acid-soaking and acid solution acidity was the most important impact to FN acidity and shelf-life for all three acid-soaking process parameters and then acid-soaking time and temperature.

REFERENCES

AACC., 1995. Approved Method of the American Association of Cereal Chemists. Association of Cereal Chemists, Inc., St Paul, MN.

Ge, Y., A. Sun, Y. Ni and T. Cai, 2001. Study and development of a defatted wheat germ nutritive noodle. Eur. Food Res. Technol., 212: 344-348.

Hatcher, D.W., S.J. Symons and U. Manivannan, 2004. Developments in the use of image analysis for the assessment of oriental noodle appearance and colour. J. Food Eng., 61: 109-117.

Lai, H.M. and S.C. Hwang, 2004. Water status of cooked white salted noodles evaluated by MRI. Food Res. Int., 37: 957-966.

Lin, J.Y., 2002. Study on keeping fresh of the wet noodle. China Food Addit., 5: 4-7.

Liu, J.J., Z.H. He, Z.D. Zhao, A.F. Liu and F.J. Pena, 2002. Investigation on relationship between wheat quality traits and quality parameters of dry white Chinese noodle. Acta Agronomica Sinica, 28: 738-742.

Liu, J.J., Z.H. He, Z.D. Zhao, R.J. Pena and S. Rajaram, 2003. Wheat quality traits and quality parameters of cooked dry white Chinese noodles. Euphytica, 131: 147-154.

Lu, Z.H., 2003. Review on production status and quality control of long-life noodles. Food Sci. Technol., 6: 58-62.

Ma, X.M., Q.S. Ding and Y.Q. Yv, 2003. Study and discuss on fresh and wet noodle. Food Sci. Technol., 29: 80-82.

Moss, R., P.J. Gore and I.C. Murray, 1987. The influence of ingredients and processing variables on the quality and microstructure of Hokkien, Cantonese and instant noodles. Food Microstruct., 6: 63-74.

Roberts, C., 1989. Fast-food fare: Consumer guidelines. New Engl. J. Med., 32: 752-756.

Saguy, I.S. and D. Dana, 2003. Integrated approach to deep fat frying: Engineering, nutrition, health and consumer aspects. J. Food Eng., 56: 143-152.

Wu, T.P., W.Y. Kuo and M.C. Chen, 1998. Modern Noodle Based Foods Product Range and Production Methods. In: Pacific People and Their Food, Blakeney, A.B. and L. O'Brien (Eds.). AACC International, St. Paul, MN., pp: 37-89.

Yang, M.D., Z.F. Long, Z.Y. Sun, C.M. Zhang and F. Gao, 2005. Study on stocking and conserve of wet noodles. J. Harbin Univ. Commerce (Nat. Sci. Edn.), 21: 83-87.

Zhang, Y., T. Nagamine, Z.H. He, X.X. Ge, H. Yoshida and R.J. Pena, 2005. Variation in quality traits in common wheat as related to Chinese fresh white noodle quality. Euphtica, 141: 113-120.

Zhou, H.M., 1997. Study on preservation of instant cooked noodles. J. Wuxi Univ. Light Ind., 16: 21-26.

Zhu, J.X., 1996. The origination and manufacture of Chinese noodles. Proceedings of the 1st Academic Congress of the Industry of Asian Cooked Wheaten Food, (ACIACWF'96), Beijing, China, pp: 20-25.