KOREAN J. FOOD SCI. TECHNOL.
Vol. 23, No. 6, pp. 649~655(1991)

Effects of Wheat Flour Protein Contents on Ramyon (deep-fried instant noodle) Quality

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Abstract

The quality of Ramyon prepared from hard red winter-western white (HRW-WW) and dark northern spring-western white (DNS-WW) flour blends having protein contents of 9.12-9.78% was examined. The noodles were manufactured by commercial process with the same water absorption. The weight and volume of cooked noodle were decreased as the protein content increased at the same cooking time. No significant differences in cooking properties were observed between noodles prepared from HRW-WW and DNS-WW blends. The weight and volume of noodle prepared from HRW-WW blend cooked for 4 min showed significant negative correlation with farinograph and extensograph data and protein contents of flours, but positive correlation with amylograph data. Such correlations were not found from noodles prepared from DNS-WW blend. Based on the sensory evaluation of cooked noodle it was concluded that the optimum protein content for noodle manufacture was in the range of 9.28-9.62%. The replacement of HRW with DNS flour had no effect on the sensory quality of noodle.

Key words: Ramyon, noodle, cooking property, protein content.

Introduction

Ramyon is one of the most popular noodles in Korea, and its consumption is estimated to be almost 10 kg per capita per year. Studies on Ramyon in Korea were centered on rancidity[1-4], because of its high percentage of lipid content (ca. 18%).

The flour quality criteria of common Ramyon in Korea are protein content of about 9.5% and ash content of below 0.55%. However, no data are available for the effect of protein content of flour on Ramyon quality.

The oriental noodle quality factors (color, eating quality and general attractiveness) are influenced by several factors such as protein content, milling yield, dough strength and starch properties[5]. The firmness and elasticity of boiled noodles generally increase with increasing protein content and dough strength[5].

Dick *et al.*[6] reported in the study of Chinese wet noodle that the panelists were unable to distinguish color and firmness differences between samples made from flours having different protein levels (in the 8.0 to 12.7% range) with the same formulation. Lee *et al.*[7] examined possible utilization of Australian wheat for Korean style dry noodle-making and suggested that flour protein content, color grade and maximum paste viscosity were important factors in determining noodle quality and that a bright, white flour of protein content 8-11% and high maximum viscosity was desirable to give the best quality.

The protein content of flour shows a significant negative correlation with noodle-making absorption[8,9] and brightness of dry noodle[7,8], but no correlation with the appearance of cooked noodle[7,10]. However, the softness and overall preference of cooked noodle have a negative correlation with the protein content of flour[7]. Oh *et al.*[8,11,12] reported that high-protein noodles had a higher cutting force than low-protein noodles. Recently, Kim[13] prepared Korean dried noodles from Australian Standard White wheats with the protein content of flour in the range of 8.0 to 9.4% and found insignificant correlation between the protein content and sensory quality of cooked noodle.

It was reported[7,13] that the peak viscosity of flour by amylograph had a positive correlation with smoothness of cooked noodle. The optimum absorption of noodle dough increases with starch damage and the fineness of granulation; decreasing particle size improves the strength of uncooked noodle but does not affect the firmness of cooked noodle[8]. The quality of dry noodle is also influenced by processing condi-

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tions[14].

Oh *et al.*[15] reported that the quality of oriental dry noodle could be evaluated by breaking stress and color of uncooked noodle and by cutting force and surface firmness of cooked noodle, and that the gluten fraction controlled the cutting stress and surface firmness and the tailing starch fraction controlled noodle color.

In the previous paper the authors[16] reported the rheological properties of noodle flours, prepared from hard red winter (HRW) and western white (WW) wheat flour, in the presence or absence of salt and alkaline reagent. To investigate the possible utilization of dark northern spring (DNS) wheat for noodle, DNS-WW flour blends were also studied. In this study the effects of HRW-WW and DNS-WW blends on the cooking properties of Ramyon were presented. The interrelationships of the cooking properties and rheological properties of flours were analyzed. The sensory evaluation of cooked noodle was also carried out to determine the optimum protein content for Ramyon manufacture.

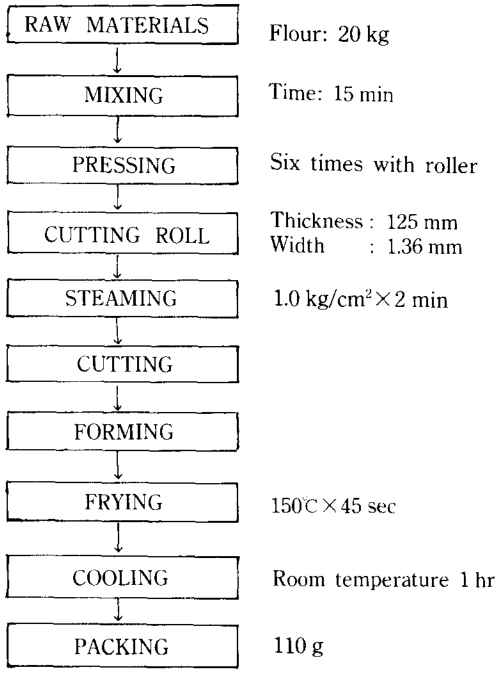

Fig. 1. Flow diagram for Ramyon processing

Materials and Methods

Materials

Commercially milled U.S. wheat flours (WW, HRW and DNS), which were equilibrated to moisture content of 13.5%, were used. The properties of the flours were reported in the previous paper[16].

Flour blends of HRW-WW and DNS-WW having protein contents of 9.12-9.78% were prepared.

Salt used was commercial food grade. Alkaline reagent employed was an equal mixture of sodium carbonate and potassium carbonate.

Manufacture of Ramyon

Formula for Ramyon manufacture was as follows: flour 100, salt 1.7%, alkaline reagent 0.17% and tap water 34.0%, based on flour weight. The salt and alkaline reagent were dissolved in water and allowed to stand for 2 hr before use.

The flow diagram for Ramyon processing is shown in Fig. 1, which is commonly practiced in commercial scale. Flour was premixed for 5 min prior to the addition of water.

Determination of cooking properties

To 200 m*l* of constantly boiling distilled water, 20 g of Ramyon was added and cooked for 7 min. The weight and volume of cooked Ramyon were measured after drainning the cooked water for 1.5 min. The volume was measured using a 250 m*l* mass cylinder containing 130 m*l* distilled water[17]. From the changes of weight and volume of Ramyon during cooking, their increase rate constants were calculated as follows:[17]

$$W_t - W_0 = k\sqrt{t} \tag{1}$$

and

$$V_t - V_0 = k_v\sqrt{t} \tag{2}$$

where W_0, V_0, W_t and V_t are weight and volume of Ramyon at cooking time zero and t, respectively, t is cooking time (min), and k and k_v are weight and volume gain rate constants (min $^{1/2}$), respectively.

The percent solubles were determined by drying the cooked water at 105℃ for 12 hr.

All experiments were repeated 5-6 times and the average value was reported.

Sensory evaluation of cooked Ramyon

Sensory evaluation of Ramyon cooked to optimum (i.e., 4 min) was carried out in two stages: difference analysis by trained panels and preference test by consumers.

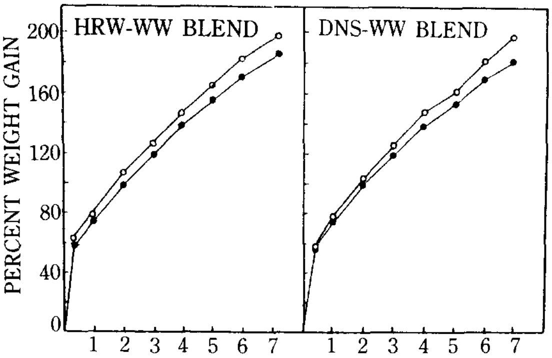

Fig. 2. Relationship between cooking time and percent weight gain of Ramyon
○—○, flour protein content of 9.12%; ●—●, flour protein content of 9.78%

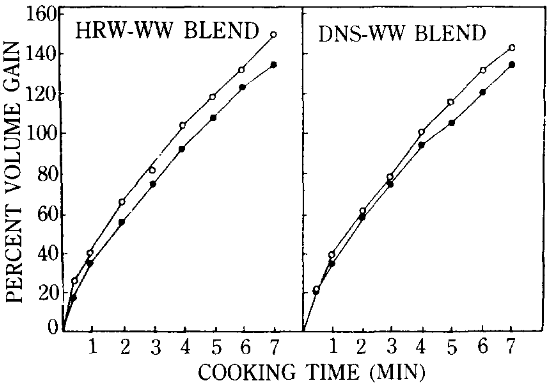

Fig. 3. Relationship between cooking time and percent volume gain of Ramyon
○—○, flour protein content of 9.12%; ●—●, flour protein content of 9.78%

About 25 students of the department of Food Science and Nutrition, Dankook University were tested and eight students were finally selected and trained for about 8 weeks.

After cooking Ramyon, each sample was rinsed in cold water for 1 min, placed in a paper cup which was coded with a three-digit random number and allowed to stand for 1 min.

The difference test by ranking was attempted to fail. The main problem was the textural changes of cooked Ramyon and blindness of taste by panelist during evaluation. Therefore, the difference analysis by triangle test was performed. Ramyon prepared from HRW-WW flour with protein content of 9.45% was served as a reference. The significance of correct judgements was evaluated using the table by Roessler *et al.*[18].

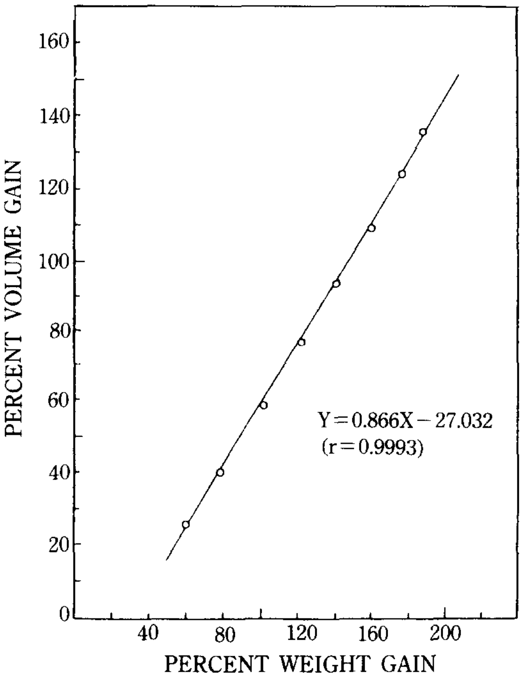

Fig. 4. Relationship between percent weight gain and percent volume gain during cooking of Ramyon

The sample pairs which were significantly different were subjected to preference test by consumers.

Results and Discussion

Changes in weight and volume

The changes in weight and volume of Ramyon during cooking are shown in Figs. 2 and 3, respectively. The weight of volume gain at a given cooking time for HRW-WW and DNS-WW Ramyon was similar. However, the degree of weight or volume increase of Ramyon was decreased as the protein content increased.

The relationship between the weight gain and volume gain during cooking of Ramyon prepared from HRW-WW blend with protein content of 9.45% gave a straight line (Fig. 4). Other Ramyon held the same trend (data not shown). The linear regression equation parameters calculated from the relationship in Fig. 4 are presented in Table 1. No significant differences in slope between Ramyons prepared from HRW-WW and DNS-WW blends were observed.

The weight gain or volume gain of Ramyon held a linear relationship with the square root of cooking

Table 1. Linear regression equation parameters from Fig. 4

Protein content (%)	HRW-WW		DNS-WW	
	Slope	Intercept	Slope	Intercep
9.12	0.885	−28.912	0.876	−28.481
9.28	0.874	−27.789	0.893	−30.892
9.45	0.866	−27.032	0.857	−26.658
9.62	0.873	−28.299	0.889	−29.224
9.78	0.908	−33.442	0.901	−30.962

Table 2. Effects of protein contents on weight and volume gain rate constants of Ramyon

Protein (%)	Weight gain rate constant ($min^{-1/2}$)		Volume gain rate constant($min^{-1/2}$)	
	HRW-WW	DNS-WW	HRW-WW	DNS-WW
9.12	0.70	0.72	0.62	0.63
9.28	0.68	0.68	0.60	0.61
9.45	0.67	0.67	0.58	0.59
9.62	0.67	0.67	0.58	0.59
9.78	0.66	0.65	0.58	0.58

time (data not shown). These results indicate that the basic mechanism of weight or volume increase of Ramyon during cooking is governed by diffusion of water, since the eq. (1) is basically identical to the diffusion equation[19]. The values for k and k_v were calculated using eq. (1) and eq. (2), respectively and the results are tabulated in Table 2. No differences in values for k and k_v between Ramyons prepared from HRW-WW and DNS-WW blends were noticed at the same protein content. However, these values showed a significant negative correlation ($p<0.05$) with protein contents.

In bread flour the water uptakes by starch, gluten and pentosans are 43.8, 30.0 and 22.5 g, respectively, per 100 g flour[20]. Based on these figures it has been estimated that 45.5% of the total water in dough might be associated with the starch, 31.2% with the protein and 23.4% with pentosans[20]. Salt has no effect on the hydration capacity of starch, but decreases the hydration capacity of gluten. At the 2% salt level, the hydration capacity of gluten decreases by about 8% [20]. The result in Table 2 in that the value of k was decreased as the protein content increased might be explained by the dilution of starch content and the reduced hydration capacity of gluten by salt.

The maximum weight and volume of Ramyon obtained after 20 min cooking were decreased with increase of protein content (Fig. 5). As indicated earlier,

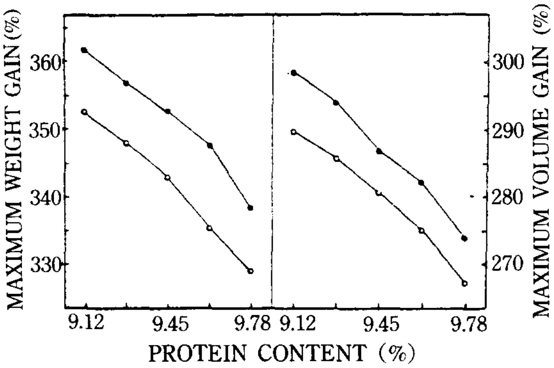

Fig. 5. Effects of protein contents on the maximum weight and volume gains of cooked Ramyon
○-○, HRW-WW blend; ●-●, DNS-WW blend

Table 3. Ratios of cooked weight and volume to maximum weight and volume of Ramyon

Protein content (%)	HRW-WW		DNS-WW	
	W/W_∞	V/V_∞	W/W_∞	V/V_∞
9.12	0.418	0.348	0.410	0.338
9.28	0.411	0.343	0.391	0.321
9.45	0.408	0.337	0.394	0.326
9.62	0.417	0.340	0.399	0.344
9.78	0.422	0.345	0.407	0.342

W and V = weight and volume after cooking for 4 min
W_∞ and V_∞ = weight and volume after cooking for 20 min

the weight or volume gain of Ramyon during cooking for 7 min did not show significant difference between HRW-WW and DNS-WW blends (Figs. 2 and 3). However, the maximum weight or volume of Ramyon was higher in DNS-WW blend than in HRW-WW blend (Fig. 5). The ratios of weight and volume of Ramyon cooked optimum to the maximum were not correlated with the protein content (Table 3).

The weight and volume of Ramyon cooked for 4 min increased consistantly upon standing for 10 min (data not shown). The weight gain or volume gain of cooked Ramyon upon standing showed a linear function with the square root of standing time (Fig. 6). The rate constants calculated from the results in Fig. 6 using eq. (1) and eq. (2) are presented in Table 4. The weight gain rate constants were slightly higher in Ramyons prepared from DNS-WW blends than those from HRW-WW blends. Tlhe rate constants were not correlated with rheological properties[16] or protein contents.

Cooking loss

The loss of Ramyon during cooking is presented

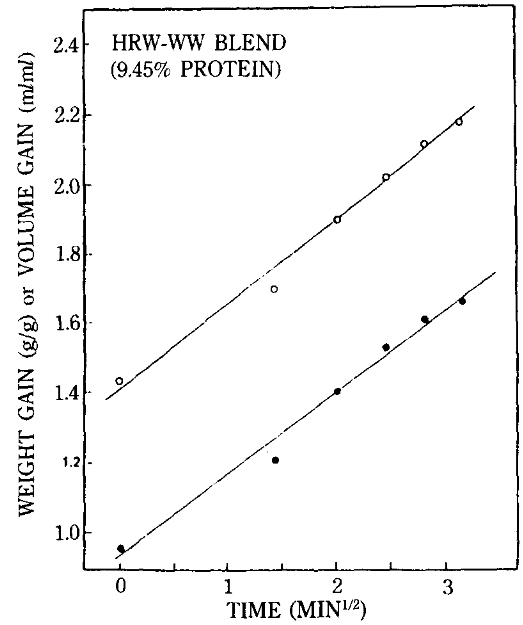

Fig. 6. Relationship between the square root of standing time and weight (○) or volume (●) gain of optimum cooked Ramyon

Table 4. Weight and volume gain rate constants of optimum cooked Ramyon upon standing

Protein	Weight gain rate contant ($min^{-1/2}$)		Volume gain rate contant ($min^{-1/2}$)	
(%)	HRW-WW	DNS-WW	HRW-WW	DNS-WW
9.12	0.2502	0.2614	0.2312	0.2430
9.28	0.2447	0.2629	0.2341	0.2357
9.45	0.2442	0.2638	0.2323	0.2361
9.62	0.2483	0.2636	0.2378	0.2350
9.78	0.2506	0.2622	0.2354	0.2506

in Table 5. The cooking loss was consistantly increased as cooking time prolonged. However, the cooking losses at cooking times of 6 and 7 min were practically the same. No significant differences between the cooking loss and the protein content and between HRW-WW and DNS-WW Ramyons at the same protein content were observed.

Oh *et al.*[12] reported that the cooking loss of dry noodle (protein content of 9.4-13.5%) cooked to optimum was in the range of 6.5-7.6%.

Correlations

Protein contents showed significant negative correlation with the weight and volume of Ramyon cooked for 4 min in case of HRW-WW blend (Table 6).

Table 5. Cooking loss (%) of Ramyon at various cooking times

Protein content	Cooking time (min)							
(%)	0.5	1	2	3	4	5	6	7
HRW-WW								
9.12	3.45	4.45	5.27	6.06	6.54	6.97	7.18	7.20
9.28	3.57	4.45	5.37	6.18	6.70	7.10	7.12	7.17
9.45	3.43	4.71	5.26	6.10	6.60	7.05	7.10	7.18
9.62	3.98	4.67	5.53	6.30	6.59	7.08	7.21	7.19
9.78	4.08	5.00	6.01	6.42	6.87	7.17	7.27	7.21
DNS-WW								
9.12	3.99	4.68	5.80	6.17	6.70	7.20	7.21	7.22
9.28	3.53	4.85	5.92	6.08	6.79	6.90	7.12	7.16
9.45	3.86	4.69	5.88	6.15	6.74	7.07	7.14	7.17
9.62	3.62	4.45	5.50	6.01	6.60	7.01	7.10	7.20
9.78	3.82	4.45	5.40	5.90	6.59	6.90	7.12	7.17

Table 6. Correlation coefficients between flour protein contents and cooked weight and volume of Ramyon

	Cooking time (min)	HRW-WW	DNS-WW
Cooked weight	4	−0.9126*	−0.7878
	20	−0.9957***	−0.9842**
Cooked volume	4	−0.9720**	−0.5906
	20	−0.9912***	−0.9905**
Cooking loss	4	−0.7615	−0.7480

*Significant at P=0.05, **Significant at P=0.01 and ***Significant at P=0.001

Table 7. Correlation coefficients between weight and volume of Ramyon cooked 4 min and rheological parameters

	HRW-WW		DNS-WW	
	Weight	Volume	Weight	Volume
Farinograph				
Absorption	−0.8932*	−0.9575*	−0.7499	−0.5533
Peak time	−0.8895*	−0.9244*	−0.8518	−0.5741
Stability	−0.9208*	−0.9609**	−0.8538	−0.6327
Time to breakdown	−0.8862*	−0.9536*	−0.8357	−0.6501
Extensograph				
Extensibility				
45 min	−0.9422*	−0.9956***	−0.8240	−0.6051
135 min	−0.8836*	−0.9181*	−0.6711	−0.5146
Resistance				
45 min	−0.9856**	−0.9805**	−0.6446	−0.4955
135 min	−0.9958***	−0.9529*	−0.6693	−0.4221
R/E 45 min	−0.9802**	−0.9615**	−0.7172	−0.5326
135 min	−0.9802**	−0.9615**	−0.7005	−0.5077
Amylograph				
Peak viscosity	+0.8877*	+0.9227*	+0.6781	+0.5292
Viscosity after 15 min at 95℃	+0.9380*	+0.9767**	+0.8031	+0.7513

*Significant at P=0.05, **Significant at P=0.01 and ***Significant at P=0.001

Table 8. Difference analysis for various Ramyons

Pair		Number of correct answers out of 36
HRW 9.45	–HRW 9.12	19
	–HRW 9.28	26***
	–HRW 9.62	16
	–HRW 9.78	18*
	–DNS 9.12	29**
	–DNS 9.28	19*
	–DNS 9.45	14
	–DNS 9.62	17
	–DNS 9.78	14

*Significant at P=0.05, ***Significant at P=0.001

Table 9. Preference of Ramyon by consumers

Pair		Numbers out of 45
HRW 9.45	–HRW 9.12	31-14**
	–HRW 9.28	27-18
	–DNS 9.12	35-10***
	–DNS 9.28	28-17
HRW 9.12	–HRW 9.28	17-8
	–DNS 9.12	26-19
	–DNS 9.28	19-26
HRW 9.28	–DNS 9.12	31-14**
	–DNS 9.28	16-29
DNS 9.12	–DNS 9.28	17-28

**Signficant at P=0.01, ***Significant at p=0.001

However, the weight and volume of Ramyon cooked for 20 min had significant negative correlation with protein content in both flour blends.

The weight and volume of Ramyon cooked for 4 min had significant negative correlations with farinograph as well as extensograph data and significant positive correlation with amylograph data in case of HRW-WW blend (Table 7).

Sensory quality of cooked Ramyon

The sensory evaluation of Ramyon cooked to optimum was performed in two stages: different analysis by triangle test and preference test by consumers.

The results on triangle test for Ramyon are given in Table 8. The Ramyon prepared from HRW-WW blend having protein content of 9.45% was served as a reference.

Ramyons prepared from flour blends having lower protein contents than the reference were significantly different from the reference Ramyon. Panels considered that Ramyon prepared from HRW-WW blend with 9.78% protein was also different from the reference Ramyon. Ramyons prepared from DNS-WW blends with protein content of higher than 9.45% were not different from the reference Ramyon.

The sample pairs which were significantly different in Table 8 were subjected to preference test by consumers.

The results of preference test for Ramyon are presented in Table 9. Ramyon prepared from flour having protein content of 9.12% was definitely inferior to others.

Based on the results in Tables 8 and 9, it can be concluded that the optimum protein level for Ramyon is in the range of 9.28-9.62%. The replacement of HRW with DNS did not show definite effect on the sensory quality of Ramyon.

Acknowledgement

This study was carried out by the grant from U.S. Wheat Associates in Seoul.

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(Received February 5, 1991)

밀가루의 단백질 함량이 라면의 품질에 미치는 영향

정구식 · 김성곤

단국대학교 식품영양학과

단백질 함량이 9.12-9.78%인 HRW-WW와 DNS-WW 밀가루를 이용하여 상업적으로 제조한 라면의 품질을 평가하였다. 조리된 라면의 무게와 부피는 일정한 조리시간에서 단백질 함량이 증가할 수록 감소하였다. 단백질 함량에 따른 HRW-WW와 DNS-WW 라면의 조리 성질은 서로 유의적인 차이가 없었다. 라면을 4분 조리한 후 무게와 부피는 HRW-WW의 경우 파리노그라프와 익스텐소그라프의 지표와는 유의적인 부의 상관을, 아밀로그라프의 지표와는 유의적인 정의 상관을 보였으나, DNS-WW의 경우에는 상관관계를 보이지 않았다. 라면의 관능검사 결과 적정 단백질 함량은 9.28-9.62%이었고 HRW를 DNS로의 대체 효과는 없었다.