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The Quality of Korean Dried Noodle made from Australian Wheats

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호주산 밀의 제면성에 관한 연구

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Abstract

Korean dried noodles were prepared from 6 different types of Australian wheats and tested for their cooking property and sensory quality. The flours from different wheat types were characterized by the fractionation of starch and gluten. The flow property of fractionated starch and flour suspensions were determined. The protein content of flour influenced many aspects of dried noodle quality. The Cooking rate decreased as the protein content increased. The higher protein content resulted in the higher of shear extrusion force, and lower grade of appearence of cooked noodle. The flours containing about 10% protein, i.e. Australian standard White flours, were appeared to be most adequate to make Korean dried noodle.

Introduction

Noodle is the most important food product made from wheat in Asian countries. In Korea many varieties of noodle products are found, among which dried noodle is the mot important. Korean dried noodle is made from wheat flour, salt and water, and differs from most of noodle products of Southeast Asian countries, where "Gansui"(sodium and potasium carbonate solution) and yellow color are used.[1]

The important quality attributes of Korean dried noodle are the strength of dried noodle strands and the color and texture of boiled noodle. The whiteness of cooked noodle is preferred and hardness, chewiness, springiness and adhesiveness are the important textural properties.[2]

Lee and Kim studied the rheological properties of Korean noodles.[3,4] The creep test of cooked noodle strand showed similar property to those of Japanese noodle reported by Shimizu et. al.[5] The mechanical parameters obtained from the creep test, however, could not satisfactorily represent the sensory quality of the cooked noodle.[6]

In the previous paper,[7] the milling property of 6 different Australian wheats was reported and the physicochemical properties of the flours were characterized by farinograph, mixograph, amylograph, sedimentation and Pelshenke tests.

In the present study, the flour properties of the 6 Australian wheat were further investigated by the fractionation of gluten and starch components. The Korean dried noodle was made from the flours and the quality was evaluated by organoleptically as well as instrumental methods including shear compression test and tensile test by using Rheometer.

Materials and Methods

Test Samples

Six different types of Australian wheat harvested in 1982 were used. The name of wheat types, abbreviation and the protein contents of the flour are listed in the below.

1. Australian Prime Hard(APH) (14.5%)
2. Australian Hard (AH) (12.2%)
3. Western Australian ASW (WAW) (10.4%)
4. South Australian ASW (SAW) (10.4%)
5. Australian Standard White (ASW) (8.1%)
6. Australian Soft Wheat (SW) (6.6%)

The flours were all patent grade having 53-58% extraction rate, as reported in the previous paper.[7]

Fractionation of Starch and Gluten

A flour dough made from 100*g* of flour were immersed in 250*ml* of distilled water for 1 hr and washed by hand. The gluten was seperated from starch by using 60 mesh sieve, washing with additional 250*ml* of distilled water.[8,9] The starch was removed from solution by sedimentation and then dried at 40℃ and ground to 60 mesh powder. The gluten was dried and the solubles were collected and dried for the calculation of material balance.

Viscosity Measurements

The flow properties of the flour as well as the starch fractions were determined by using Bookfield Syncrolectric Viscometer with UL adapter. A suspension containing 1.5% of flour or starch were prepared and heated at 98℃ for 5 min and cooled immediately with cold running water for 3 min. The viscosity was measured at 25±1℃ with varing speed of spindle revolution and for various shearing time. The flow behavior index and consistency index were estimated by power law equation and yield stress by Casson's equation.

Preperation of Dried Noodle

The traditional Korean dried noodles were made by local manufacturer. One Kilogram of flour were mixed with 10% NaCl solution. The NaCl solution was added to the flour until it reached by the subjective judgment of the expert to the proper consistency to make dough sheet. The amount of NaCl solution used to each flour sample was measured. The noodle dough passed through kneading roll, sheeting roll of 30*mm* gap and calibrating roll of 1.6*mm* clearance and then finally cutting roll of 1.5 *mm* width to make noodle strand.

The noodle strands were hung on a bamboo rod and dried in the air. The dried noodle was cut into 20*cm* length and packed in a bundle of 5*cm* diameter and stored in dark place.

Cooking Test

A few strand of dried noodle was weighed and cooked in 1*l* of boiling water. For each 30 sec of time interval, noodle strands were taken from boiling water and weighed after 30 sec of cooling and draining. The water absorption rate with cooking time was calculated. The noodle strand was cut with a blade and the uncooked core size was measured by using(5x) magnifying glass and a caliper.

Mechanical Tests of Cooked Noodle

In a preliminary study, different mechanical test methods were studied for their reliability. Tensile test gave very fluctuating data. The shear extrusion test was appeared to be most reliable among the methods tested. For shear extrusion test, a Rheometer adapter was constructed in the laboratory. A stainless cylinder of 26.45*mm* inner diameter were attached in the bottom a stainless steel net having 2 x2*mm* holes. The cooked noodle made from 1.8*g* of dried noodle were put in the cylinder and extruded by the compression test probe having 25.60*mm* diameter. The force required to complet extrusion of cooked sample was taken as the shear extrusion force.

Sensory Evaluation

A total of 6 panel member were selected from the graduate students of Department of Food Technology, Korea University, and trained for sensory evaluation of noodle products. A scalar scoring test method was adopted. The highest value 6 was given to mark excellent and the lowest value 1 was given to very poor.

The cooked noodle boiled in water for 6 min was given to the panel. The panel was asked for the appearence and overall preference. For the overall preference test, the reason for the different preference between samples were asked.

Result and Discussion

Fractionated Components

Table 1 shows the contents of fractionated gluten, starch and soluble materials of different Australian wheat flours. The amount of gluten fraction was related to the protein content of flour except for SAW; APH had the largest gluten content, while SW showed the lowest value. The amount of gluten of AH was lower than expected from the protein content and SAW gave higher amount. The amount of fractionated starch was reversely related to the gluten content.

The gelatinized starch solutions showed strong thixotropic property for the first 20 min of shearing, but since then become unaffected by shearing time, as shown in Fig. 1. The time to reach to the equilibrium shear stress was about 20 min for all the 6 wheat samples tested.

Fig. 2 shows the plot of shear stress against shear rate of gelatinized wheat starch measured at the shearing time 40min. The starch fraction made from SAW showed exceptionally low value of shear stress.

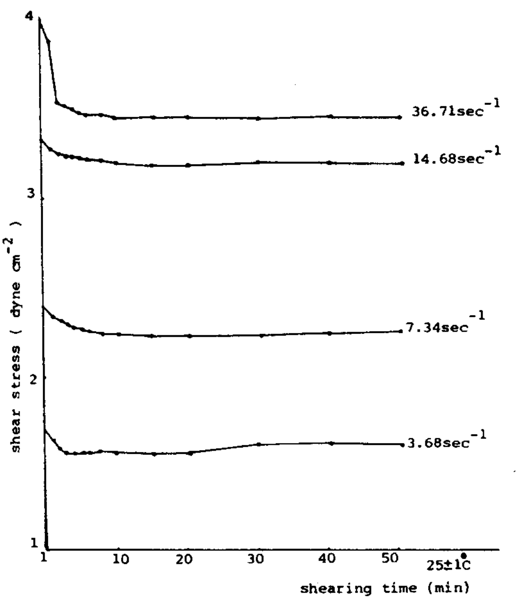

Fig. 1 Change of shear stress τ as a function of shearing time for WAW gelatinized starchwater solution

Table 1. Various fractionated component of 6 different Australian wheat flours

	Fractionated gluten (%, db)	Fractionated starch (%, db)	Soluble materials (%,db)
APH	12.3	79.7	8.0
AH	9.9	77.0	13.2
WAW	9.3	82.6	8.1
SAW	10.1	79.6	10.3
ASW	7.7	85.6	6.7
SW	6.4	86.1	7.5

All the gelatinized starch solutions showed pseudoplastic property. The flow behavior index of WAW was very low, indicating the strongest pseudoplastic property, while SAW had higher value, as shown in Table 2. The yield stress and consistency index of WAW starch were 200 times and 10 times, respectively, bigger than those of SAW starch. Both WAW and SAW were intermediate protein flour, but their starch property was quite different. This difference could explain the results of amylograph data reported in the previous paper. The maximum amylograph viscosity of WAW was 830 B.U., whereas that of SAW was 480 B.U.[7]

Table 2. Flow behavior index, consistency index and yield stress of gelatinized wheat starch(1.5%)-water

	Flow behavior index	Consistency index	Yield stress
APH	0.443	0.744	0.694
AH	0.588	0.450	0.378
WAW	0.350	1.078	1.192
SAW	0.792	0.101	0.055
ASW	0.445	0.784	0.785
SW	0.527	0.505	0.528

Consistency index : dyne sec^{n-2}/cm^2

Yield stress : $dyne/cm^2$

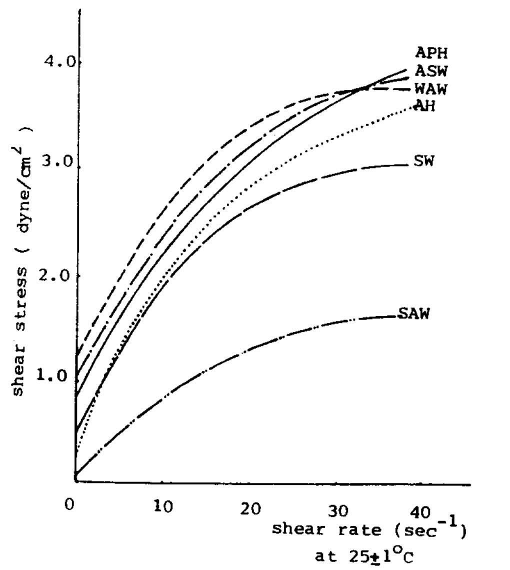

Fig. 2 plot of shear stress τ against shear rate γ̇ for gelatinized wheat starch

The flow behavior of gelatinized flour suspensions showed somewhat different results. As shown on Fig. 3, the SW and AH showed also very low shear stress as SAW did, but WAW, APH and SAW exhibited high shear stress. WAW and ASW showed exceptionally low values of flow behavior index, high consistency index and high yield stress, as shown in Table 3. This result may indicate that the flow behavior of flour suspension is not only governed by the starch but significantly influenced by protein content and other factors of unknown.

Amount of Water added for Dough Mixing

The amount of water required to make proper noodle dough was empirically determined by the subjective judgement of skilled noodle manufacturer. As shown in Table 4, the amount of 10% NaCl solution added to the flour to make proper dough was varied with the type of flours. Both hard and soft wheat flours required larger amount water than Australian stand White flours. The amount of water added to make dough was significantly related(r=0.956) to the amount of water absorption measured by mixograph.[7]

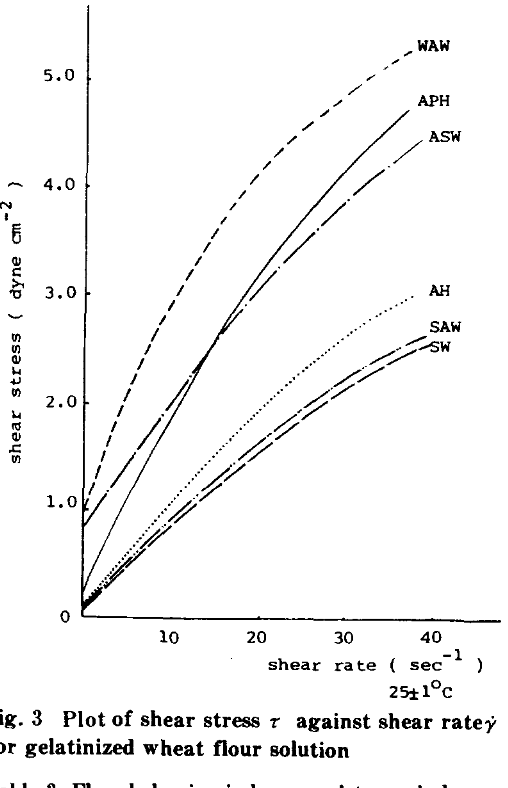

Fig. 3 Plot of shear stress τ against shear rate $\dot{\gamma}$ for gelatinized wheat flour solution

Table 3. Flow behavior index, consistency index and Yield stress of gelatinized wheat flour (1.5%)

	Flow behavior index	consistency index	Yield stress
APH	0.814	0.268	0.347
AH	0.858	0.142	0.204
WAW	0.568	0.723	0.886
SAW	0.914	0.100	0.143
ASW	0.583	0.540	0.691
SW	0.898	0.097	0.018

Cooking Rate of Dried Noodle

The rate of water absorption and the time for disappearing the inner uncooked core of noodle strand during cooking of dried noodle were determined as the parameters for cooking rate. Fig. 4 shows typical curves of water absorption of APH and SW. The other noodles made by different flours fell in between these curves. The maximum water absorption was reached by 9 min of cooking, after which the release of starch and solid matters from noodle into boiling water became significant. The size of inner core of noodle strand decreased as the cooking proceed. The time for disappearing inner core appear to be related to the amount of water

Table 4. The amount of water required to make proper noodle dough

Flour type	*ml* of 10% NaCl added to 1 *kg* flour
APH	325
AH	310
WAW	290
SAW	295
ASW	290
SW	300

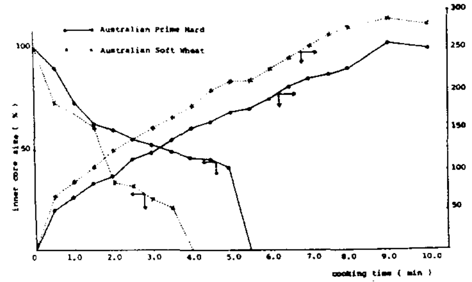

Fig. 4 Inner core size and water absorption of APH and SW noodle at various cooking time

Table 5. The time for disappearing the inner core of noodle strand and the amount of water absorbed by boiling for that time

Type of flour	Time for disappearing inner core (min)	Absorbed water (wt. % of dried noodle)
ApH	5.5	175.7
AH	4.5	176.4
WAW	4.5	176.8
SAW	4.0	163.2
ASW	4.0	166.1
SW	4.0	177.8

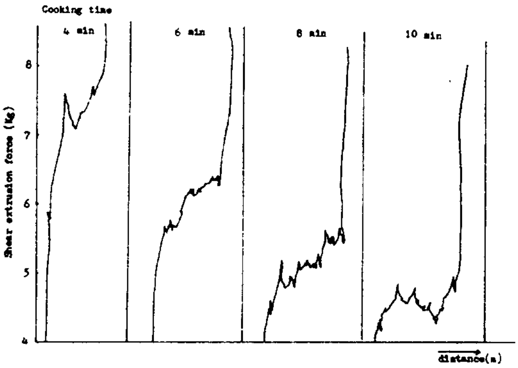

Fig. 5 Shear extrusion force of WAW wheat flour noodle at various cooking times

absorbed. Table 5 shows the time for disappearing inner core of noodle and the amount of water absorbed at that time. The inner core disappeared when the amount of absorbed water was 163-178% of dried noodle weight. The higher protein content tended to require longer cooking time.

Mechanical Properties of Cooked Noodle

Fig. 5 shows a typical force distance curve of shear extrusion test of cooked noodle. The shear extrusion force was taken from the average between the highest value and the lowest value in the shear extrusion curve.

Table 6 shows shear extrusion force of noodles cooked for various times. The shear extrusion force of cooked noodle tended to decrease as the cooking time increased. The shear extrusion force appeared to be related to the protein content of the flour ; the higher protein content resulted in the higher shear extrusion force.

Table 6. Shear extrusion force of noodles at various cooking times

Noodles	Cooking time (min) 4	6	8	10
APH	8.0	6.3	5.5	3.8
AH	6.9	5.9	4.1	3.6
WAW	7.1	5.1	4.6	3.5
SAW	7.0	4.9	4.1	3.4
ASW	6.7	5.1	4.1	3.7
SW	5.5	4.1	3.8	3.0

Constant compression speed : 3.4*mm* sec

Unit : *kg*

Sensory Evaluation

The appearence of dried noodle and cooked noodle were evaluated by the sensory panel. The high lightness and shiny white color were preferred. The cooked noodle made from APH and AH attained slightly grayish color. The appearence score were inversely related to the protein content of the flour, as shown in Table 7. The appearence of dried noodle matched to the appearence grade of cooked noodle.

Table 8 shows the overall taste preference of cooked noodles made from different Australian wheats. WAW and SAW made the best quality of noodle, while APH were not adequate. The characteristic textural properties influencing the taste score were evaluated by counting the frequency of the textural term mentioned by the panel. Springy, chewy, smooth, mush and firm were the textural term appeared often. Table 9 summarizes the frequency of the appearence of characteristic sensory expression

Table 7. Comparison of the appearence of noodles made from Australian wheat varieties

	APH	AH	WAW	SAW	ASW	SW
Before cooking	*	*	* * *	* * *	* * * *	* * * *
After cooking	*	* *	* * *	* *	* * * *	* * * *

**** : very good

* : very poor

for the texture of cooked noodles made from different Australian wheats. Springy and chewy were the term expressed for acceptable noodle and mush and firm represented the poor quality of cooked noodle, as related in Fig. 6.

The shear dxtrusion force could also be related to the springy and softness of the textural characteristics. As shown in Fig. 7, shear extrusion force was inversely related to soft and had second order relationship with springy character. The protein content and appearence were second order functions to the overall preference of cooked noodle, as shown in Fig. 8. The flours containing about 10% of protein, i.e. WAW and SAW, were appeared to be most adequate

Table 8. Overall preference* of noodles made from different varieties of Australian wheat

	WAW	SAW	ASW	AH	SW	APH
Mean score	4.5	4.4	3.8	3.5	3.4	2.3
Significance level $p<0.01$						

*Mean score of hedonic scoring test

Sensory score: 6; excellent, 5; very good, 4 ; good, 3; fair, 1; very poor.

Table 9. Frequency of the appearence of characteristic sensory expression for the texture of cooked noodles made from different varieties of Australian wheat

	WAW	SAW	ASW	AH	SW	APH
말랑말랑(springy)	6	7	7	2	1	0
쫄깃쫄깃(chewy)	8	9	2	6	2	2
연하다(soft)	4	2	1	0	5	0
미끈미끈/매끈매끈(smooth)	3	4	1	5	2	1
푸르다(mush)	4	0	2	1	11	2
굳다(firm)	0	3	7	7	0	12

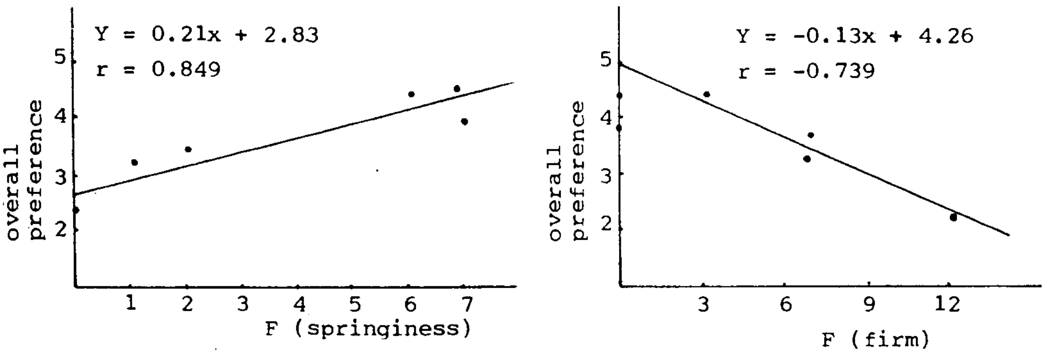

Fig. 6 Relationships between overall preference and frequency(F) of expressions on sensory attributes of noodles

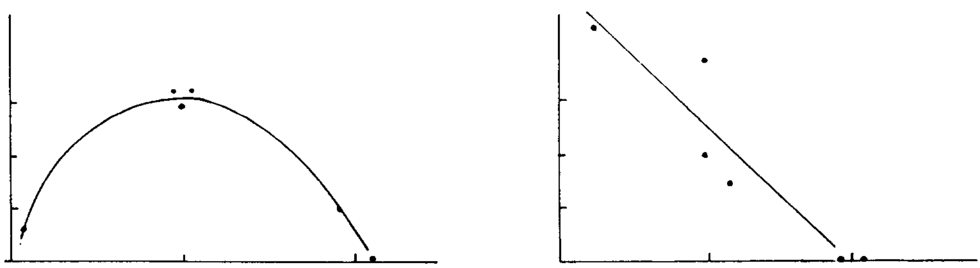

Fig. 7 Relationships between frequency of expression on sensory attributes of noodles and mechanical properties of noodles

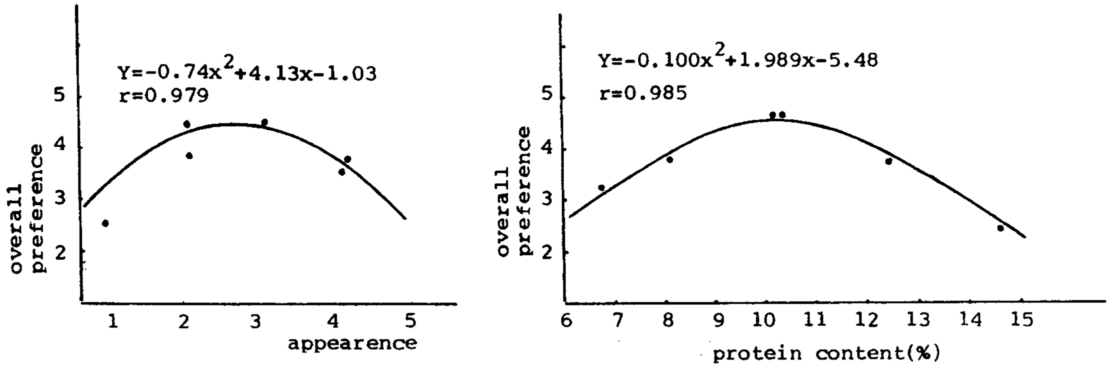

Fig. 8 Relationships between sensory overall preference and appearence and protein content

to make Korean dried noodle.

It was interesting to note that no apparent influence of the flow behavior of starch fractions on the noodle quality could be observed. However, with the limitted number of flour samples used in this experiment it was difficult to establish any conclusive relationship between the physicochemical properties of flours and the sensory quality of Korean dried noodle.

요 약

여섯 종류의 호주산 밀을 이용하여 한국 재래식 건조 밀국수를 제조하여 조리특성과 관능적 품질을 비교평가 하였다. 밀가루의 성질을 구체적으로 파악하기 위하여 글루텐과 전분으로 분획하여 전분의 유동특성을 규명하였다. 국수의 품질은 사용한 밀가루의 단백질 함량에 크게 영향을 받았으며 단백질 함량이 높을수록 국수를 삶는데 필요한 시간이 길어졌으며 삶은 국수의 층밀림 압출력이 커지며 외관은 불량하여 졌다. 단백질 함량이 10% 수준의 중력분을 나타내는 Western Australian wheat 과 South Australian wheat 가 한국 재래식 건조 밀국수의 제조에 가장 적당 하였다.

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