Nutritional Quality and Food-Making Performance of Some Triticale Lines Grown in Korea

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한국산 Triticale의 식품 이용에 관한 연구

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Abstract

Three winter wheats and 3 triticales grown in Korea were compared for nutritional quality and food-making performance. The flour yield of triticale was 54 % below that of wheat, while triticale was higher in protein than wheat. The amino acid composition of triticale flours was similar to that of wheat flours. The essensial amino acid compositions were slightly higher in triticale flours. Noodles of acceptable quality were produced from triticale flours. The bread produced from triticale flours was somewhat inferior to that from soft wheat flours. The triticale flours produced bread of slightly lower quality than the soft wheat flours. The specific loaf volume were lower, the grain more rough, the texture slightly harsher and the crumb color slightly darker.

Introduction

Triticale is a man-made cereal grain. The parental species are wheat and rye. It was developed by the combination of Triticum(wheat) and Secale (rye) genomes (Fig. 1). Although it had its begining in the late 1800s in Europe[1,2], triticale has been of little economic importance and has only been grown on small experimental plots, until recently[3]. Triticale, however, was found to have several merits including higher protein content and better essential amino acid balance than wheat.

Due to an intensive breeding work, commercial triticale varieties are now available. Commercial production of triticales in the U.S.A. began about 1970 with an estimated acreage of 30,000[6]. It is believed that production has now increased to 200,000 acres [3,6]. Triticale flours have been used for animal feed and many food products[7~13], demonstrating that this man-made cereal has potential in many food applications. The quality of cereal grains largely depends on environmental factors[14,15]. Triticales are now grown on an experimental scale in Korea.

It was the purpose of this study to evaluate the nutritional quality and food-making performance of some triticale lines grown in Korea.

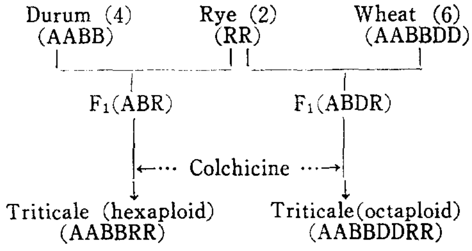

Fig. 1. Triticale is made by combination of wheat and rye genomes

Numericals indicate the number of ploids

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Materials and Methods

Six grain samples, all grown in Suwon, Korea, were selected for this study. The three winter wheats, Chokwang, Wonkwang and Yungkwang, and the three hexaploid triticales, M_1A, Tejeon-IRA and $TclF_3$-IRA, were milled on a Buhler test mill. The triticale samples were tempered to 14 % moisture for 24 hr, while the wheat samples were tempered to a moisture content of 14.5 % for 24 hr.

Proximate analyses of grains and flours were carried out by A.A.C.C. procedures[18] and amino acid analyses were carried out as follows. Each 20 *mg* of flour samples containing about 1.5 *mg* of nitrogen was tested for its amino acid analysis. The hydrolysis of samples to amino acids was achieved by heating them with 6 *N* HCl at 110°C for 24 hr. The amino acid was quantitatively determined in duplicate hydrolyzates with a Yanagimoto Model LC-5 Automatic Amino Acid Analyzer.

Amylograph characteristics of flours were investigated with a Brabender Amylograph[18]. Farinograph data were obtained with a Brabender Farinograph using 50 *g* flour samples[19]. Alpha-amylase was assayed by the methods proposed by Matewson[20] and Barns *et al.*[21].

The unit of α-amylase activity, called the dextrinizing unit (DU), is defined as the quantity of α-amylase which dextrinizes soluble starch at the rate of one *g* per hr at 20°C.

The noodle making formula was 100 *g* flour (14 % moisture basis), 2 % salt, and 32 *g* water. The doughs were mixed in an Alveo-mixer for 10 min. The dough was sheeted with an Ohtake Noodle Making Machine to a thickness of 2 *mm*. The noodles (about 132 *g*) were cooked in an Ohtake Noodle Cooker for 10 min in 1 *l* of boiling water. Cooked weight of noodles was determined by draining the noodles for 2 min in a plastic net container and recording the weight of the driained noodles. The solid extracts of the cooked water were expressed as turbidity which was determined spectrophotometrically at 650 nm.

The triticale and wheat flours were baked according to the straight dough precedure[22]. The composition of the baking formula used was 100 *g*(14 % m.b.) flour, salt 2 %, sugar 5 %, shortening 3.5 %, skim milk 4 %, dry yeast 2 %, yeast food 0.5 %, and water variable. The bread dough was mixed in a Baking-mixer (National MFG). The mixing speed was 110 r.p.m. Dough was placed in baking pans for fermentation of 90 min at 30°C. The loaves were then baked for 20 min at 200°C in a Rotary oven (National MFG).

Results and Discussion

Grain characteristics and milling properties

Grain characteristics of triticale and wheat are given in Table 1. Although triticale has a large kernel, the test weight of triticale is lower than that of wheat. A low test weight in triticale may be attributed to the shrivelled condition of triticale kernel.

Triticale had flour yields, total and patent flour, below those of wheat (Table 2). These findings are in agreement with those reported by several foreign researchers[3,8,23]. These poor yields have been attributed to the shrivelled condition of the triticale kernels, which does not permit efficient seperation into milling fractions. Relatively large amounts of endosperms, which should have been part of flour fraction, remained with the bran and shorts, thus lowering the flour yield while raising the yield of

Table 1. Grain characteristics of triticale and wheat

	Triticale			Wheat		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
1000 grain weight (*g*)	39.5	48.5	42.9	38.2	31.7	36.4
Test weight (*g/l*)	664	622	619	788	770	711
Grain protein (%)	13.0	12.9	15.1	10.7	9.7	10.5

Table 2. Milling data of triticale and wheat

	Triticale			Wheat		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
Break flour (%)	17.7	15.3	12.3	20.3	21.3	21.2
Reduction flour (%)	37.6	38.3	41.7	47.7	46.2	46.0
Patent flour (%)	47.6	46.9	48.5	60.4	58.3	60.7
Total flour (%)	55.3	53.6	54.0	68.0	67.5	67.2
Shorts (%)	26.3	32.0	27.0	16.6	9.0	11.0
Bran (%)	18.4	14.4	19.0	15.4	23.5	21.8

Table 3. Milling score and milling score index of triticale and wheat

	Triticale			Wheat		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
Flour yield (%)	55.3	53.6	54.0	68.0	67.5	67.2
Flour ash* (%)	0.61	0.53	0.64	0.52	0.53	0.49
Milling score	59.8	62.1	57.0	77.0	76.0	77.7
Milling score index**	83.0	84.9	77.9	118.8	116.9	119.1

* On 14 % m.b. ** Milling score index (MSI) = 2.3 × yield − 72.4 × ash

shorts and bran.

As shown in Table 3, ash contents of triticale flours were rather higher despite the low flour extraction rates. As a result, triticale had a lower milling score[24] and milling score index[25]. The milling score index of triticale ranged from 77.9 to 84.9(average 82.0).

Proximate analysis and amino acid composition

It has been recently reported that triticale can be a source of protein[4,5]. The protein contents of grain and flours are given in Table 1 and 4. Triticale had grain protein levels of 13~15 % and flour protein levels of 10~12 %. The grain protein levels of triticale were higher than those of wheat.

Amino acid compositions of wheat and triticale flours are summarized in Table 5. The major amino acids of wheat and triticale flours were glutamic acid and proline. Small differences, however, were found for the two amino acid levels. Triticale flours had slightly higher proline and lower glutamic acid than wheat did. This is mainly attributed to the amino acid composition of rye. Kies *et al.*[27] reported very similar results.

The lysine contents of triticale and wheat flours were varied among varieties. M_1A has relatively high lysine. As shown in Table 5, the essential amino acid compositions were slightly higher in triticale flours. The limiting amino acid of triticale flours was, however, lysine also as in flours.

Rheological properties of flours

Farinograph curves of wheat and triticale flours are shown in Fig. 2. Shorter arrival times and peak

Table 4. Proximate analysis of triticale and wheat flours

	Triticale			What		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
Crude protein (%)	10.8	9.9	12.2	9.5	8.8	9.4
Crude lipid (%)	0.85	0.85	0.82	0.92	0.86	0.84
Carbohydrate (%)	73.74	74.62	72.34	75.06	75.81	75.27
Ash (%)	0.61	0.53	0.64	0.52	0.53	0.49

* On 14 % moisture basis

Table 5. Amino acid composition of triticale and wheat flours *mg*/100 *mg* protein

Amino acid	Triticale			Wheat[26]		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
Lysine	**2.21**	1.75	1.57	1.95	2.06	1.91
Histidine	1.95	1.26	1.33	1.87	1.92	1.89
Ammonia	2.47	2.65	2.67	4.52	4.56	4.53
Arginine	3.68	4.08	4.20	2.92	2.96	2.84
Aspartic acid	4.36	5.61	5.86	4.48	4.71	4.41
Threonine	2.74	2.75	2.87	2.76	2.69	2.76
Serine	4.50	2.31	4.83	5.62	5.36	5.51
Glutamic acid	32.33	32.71	34.83	**35.25**	**35.34**	**35.75**
Proline	**16.06**	**15.02**	11.61	12.34	11.87	11.89
Half cystine	0.88	1.29	1.07	0.82	0.67	0.75
Glycine	3.23	3.68	3.82	3.65	3.59	3.60
Alanine	3.00	3.49	3.40	3.21	3.19	3.28
Valine	4.14	5.24	2.13	3.08	3.00	3.08
Methionine	1.49	1.57	1.38	1.56	1.59	1.59
Isoleucine	2.98	2.50	3.59	2.56	2.44	2.50
Leucine	6.26	6.35	7.06	6.63	6.75	6.72
Tyrosine	2.93	2.79	3.02	2.10	2.35	2.24
Phenylalanine	4.79	4.95	4.97	4.68	4.94	4.76
Essential amino acid (%)	24.61	25.11	23.57	23.22	23.47	23.22

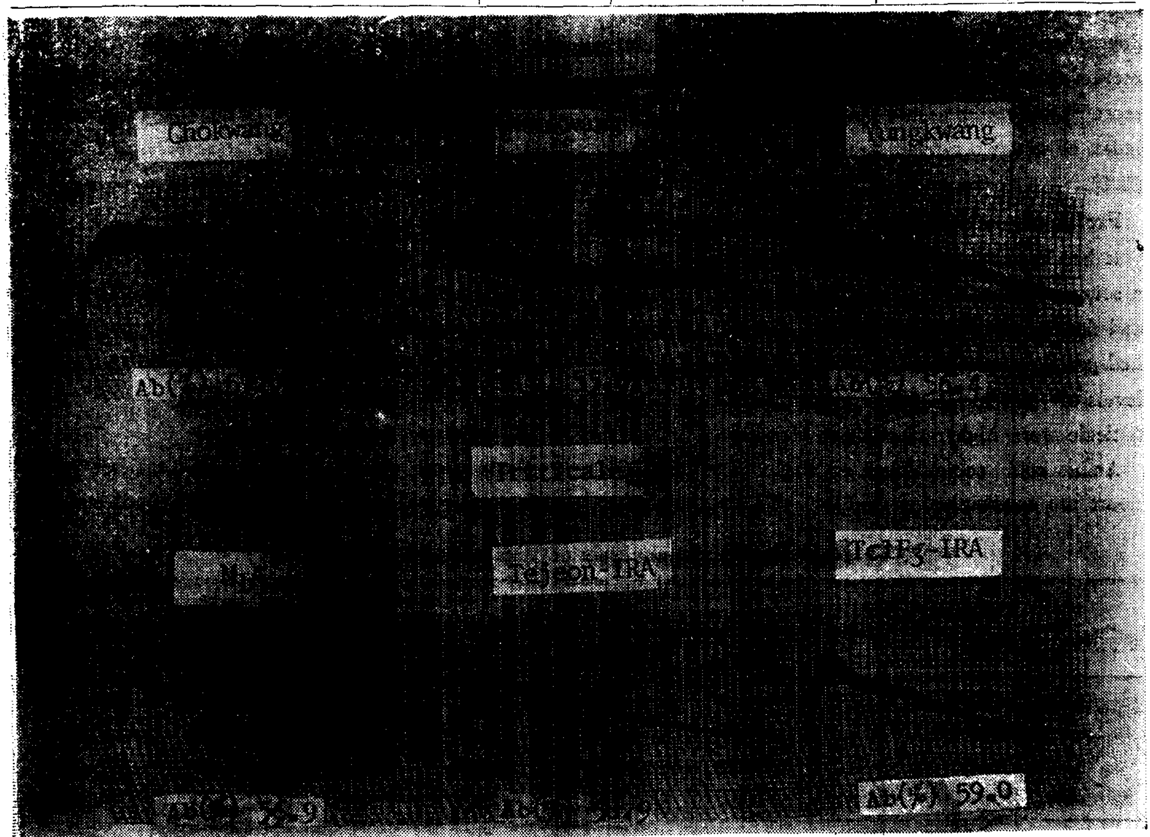

Fig. 2. Farinograph curves of wheat (top) and triticale (bottom) flours

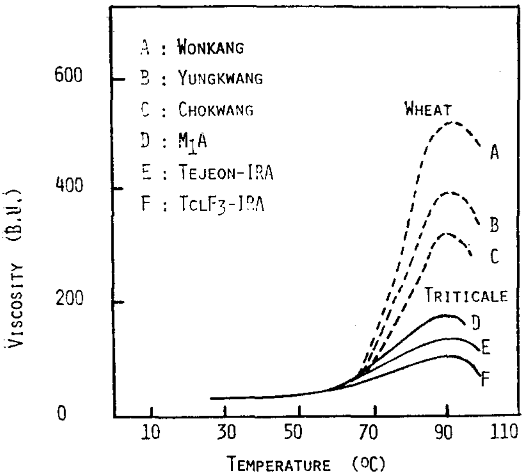

Fig. 3. Amylograph profiles of triticale and wheat flours

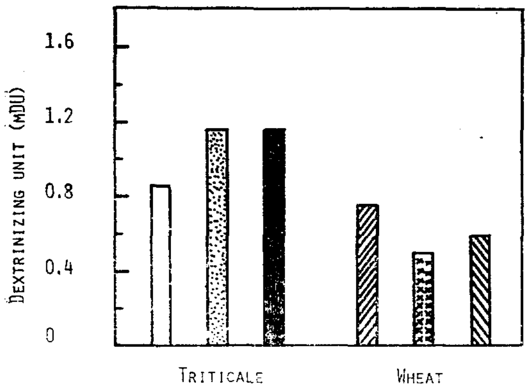

Fig. 4. α-Amylase activity of triticale and wheat flours

□ : M_1A, ▒ : Tejeon-IRA,
■ : $TclF_3$-IRA, ▨ : Chokwang,
⊠ : Wonkang, ▧ : Yungkwang

times and peak times were obtained for triticale flours, indicating faster uptake of water and faster development. Dough stability times and mixing tolerance indices(MTI) of triticale flours were considerably lower than those of wheat flours. Shorter mixing times and tolerances of triticales have been reported by others[8~10]. Triticales were higher in water absorption of farinograph than wheats. This is mainly due to their high protein contents.

Amylograph characteristics of wheat and triticale flours are shown in Fig. 3. Amylograph viscosities of the triticale flours were considerably lower than those of the wheat flours. The lower amylograph viscosities of triticale flours indicate a high α-amylase activity(Fig. 4). The higher α-amylase in triticale flours may be attributed to rye, which has a high α-amylase acti- vity. A high α-amylase activity has been reported in other triticale lines[11~13]. A higher α-amylase activity in triticale flours is one of the important problems as regards to its food usage[3,28].

Noodle and bread-making characteristics of flours

Korean type noodles made with triticale and wheat flours are shown in Fig. 5. Generally, the noodles became softer as cooking times increased. The noodles prepared with the triticale flours showed an off-white color in contrast to the white color of wheat noodles. The off-color is mainly due to the high ash content of triticale flours. The triticale flours, milled from M_1A variety, produced satisfactory noodles, as seen in Table 6. The color and the texture of the noodles were good. The flours milled from the triticale line, Tejeon-IRA also produced noodles of satisfactory quality. The flours from $TclF_3$-IRA, however, were unsuitable for noodle-making mainly due to

Table 6. Noodle characteristics of triticale and wheat flours

	Triticale			Wheat		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
Uncooked noodle						
Color	greyish white	greyish white	dark grey	white	greyish white	white
Appearance	good	good	fair	excellent	good	excellent
Cooked noodle						
Weight(% Wt. gain)	178	188	192	162	183	175
Turbidity of soup*	0.74	0.85	0.91	0.68	0.78	0.69
Texture	hard	brittle	brittle	hard	brittle	hard

*Turbidity of soup after cooking was determined at 650 nm

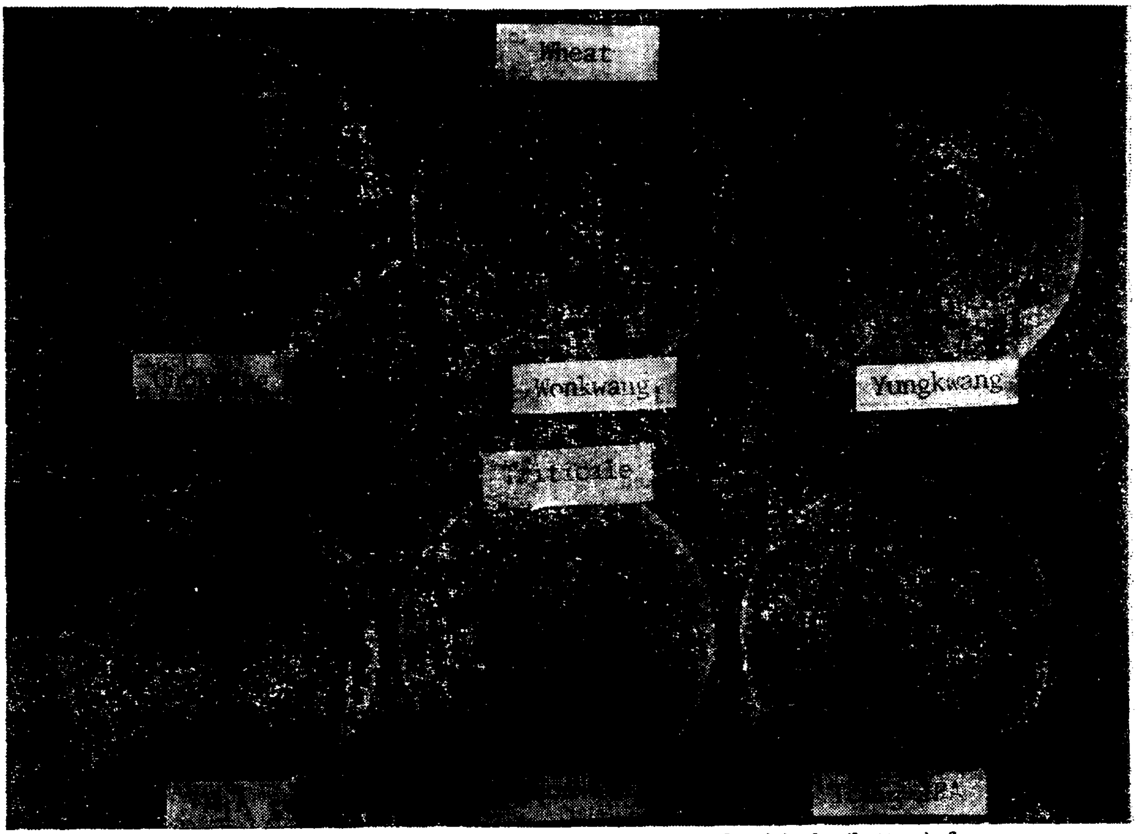

Fig. 5. Korean type noodle made with wheat (top) and triticale (bottom) flours

Table 7. Baking data on triticale and wheat flours

Baking data	Triticale			Wheat		
	M_1A	Tejeon-IRA	$TclF_3$-IRA	Chokwang	Wonkwang	Yungkwang
Loaf volume (cc)	727	665	566	715	697	752
Loaf weight (*g*)	160.7	159.3	154.3	156.7	155.3	166.0
Specific loaf volume (cc/*g*)	4.52	4.18	3.67	4.56	4.49	4.53
Crumb grain*	S	U	U	S	Q	S
Crumb color*	Q	U	U	S	Q	S

*S : Satisfactory Q : Questionable U : Unsatisfactory

their dark grey color. The cooked weight, expressed as percent weight gain, of the noodles is presented in Table 6. The triticale noodles showed a considerably higher cooked weight than did the wheat samples. This indicates faster uptake of water in the cooking of triticale noodles. The breads baked with wheat and triticale flours were illustrated in Table 7. Triticale doughs required a higher absorption and a longer mixing time than wheat. The triticale flours produced bread of slightly lower quality than the soft wheat flours. The specific loaf volumes were lower, the grain more rough, the texture slightly harsher, and the crumb color slightly darker. However, the bread quality of M_1A variety was relatively acceptable. The speciefic loaf volume of M_1A bread was 4.52, which was similar to those of soft wheat flours. In agreement with results obtained by other researchers[7,8], breads of acceptable quality can be produced with certain varieties of triticale.

요 약

한국산 triticale과 연질 밀을 사용하여 그들의 이화학적 특성, 제분 특성 및 제품 특성을 조사하였던 바 그 결과를 요약하면 다음과 같다.

1. Triticale은 단백질 함량이 높고 아미노산 조성도 밀 보다 양호하였으나 제한 아미노산은 역시 lysine이었다.

2. Triticale의 식품 이용상의 문제점은 밀가루 수율이 떨어진다는 점과 α-amylase 역가가 높다는 점이었다.

3. 밀가루 수율은 밀보다 약 10% 정도 낮았으며 제빵으로 이용하는 경우 빵의 용적이 밀 보다 떨어졌다.

4. 그러나 triticale도 국수 제조에는 큰 문제가 없었으며 M_1A 품종의 경우 특히 국수 적성이 양호하였다.

References

1. Larter, E. N., Shebeski, L. H., Mcginnis, R. C., Evans, L. E. and Kaltsikes, P. J. : *Can. J. Plant Sci.*, **50**, 122 (1970)
2. Briggle, L. W. : *Crop Sci.*, **9**, 197 (1969)
3. Lorenz, K. : *Food Technol.*, **26**(11), 66 (1972)
4. Waggle, D. H., Lambert, M. A., Miller, G. D., Farrell, E. P. and Ceyoe, C. W. : *Cereal Chem.*, **44**, 48 (1967)
5. Kies, C. and Fox, H. M. : *Cereal Chem.*, **47**, 671 (1970)
6. Kuroda, N., Ohnishi, M. and Fujino, Y. : *Cereal Chem.*, **54**(5), 997 (1977)
7. Unrau, A. M. and Jenkins, B. C. : *Cereal Chem.*, **41**, 365 (1964)
8. Lorenz, K., Welsh, J., Normann, R. and Maga, J. : *Cereal Chem.*, **49**, 187 (1972)
9. Tsen, C. C., Hoover, W. J. and Farrell, E. P. : *Cereal Chem.*, **50**, 16 (1973)
10. Kissell, L. T. and Lorenz, K. : *Cereal Chem.*, **53**, 233 (1976)
11. Lorenz, K., Dilsaver, W. and Lough, J. : *J. Food Sci.*, **37**, 764 (1972)
12. Lorenz, K., Welsh, J. Normann, R. Beetner, G. and Frey, A. : *J. Food Sci.*, **39**, 572 (1974)
13. Pomeranz, Y., Burkhart, B. A. and Moon, L. C. : *Triticale in Malt and Brewing*, Am. Soc. Brewing Chem. Proc., p. 40 (1970)
14. Ryu, I. S., Shin, H. K., Cho, J. H. and Bae, S. H. : *J. Korean Soc. Crop Sci.*, **22** (2), 65 (1977)
15. Zillinsky, F. J. and Borlaug, N. E. : *Agr. Sci. Rev.*, **9**(4), 28(1971)
16. Baker, H. W. and Gregory, N. L. : *Cereal Chem.*, **19**, 267 (1942)
17. Harris, R. H., Mackenzie, J. M. and Seeborg, E. F. : *Trans Am. Assoc. Cereal Chemists*, **11**, 182 (1953)
18. American Association of Cereal Chemists : *A.A.C.C. Approved Methods*, The Association, St. Paul, Minn. (1962)
19. American Association of Cereal Chemists : *The Farinograph Handbook*, The Association, St. Paul, Minn. (1960)
20. Mathewson, P. R. and Pomeranz, Y. : *J. of A.O.A.C.*, **60**(1), 16(1977)
21. Brans, W. C. and Blakeney, A. B. : *Die Starke*, **26**, 193 (1974)
22. Finney, K. F. : *Cereal Chem.*, **22**, 149 (1945)
23. Michela, P. and Lorenz, K. : *Cereal Chem.*, **53** (6), 853 (1976)
24. Seeborg, E. F. : *Cereal Chem.*, 11, 1 (1953)
25. Ryu, I. S., Shin, H. K. and Bae, S. H. : *J. Korean Agr. Chem. Soc.*, **21**(3), 193 (1978)
26. Ryu, I. S. : *Studies on Quality Characteristics of Korean Wheat Varieties*, Report of Official Trip to United States, Office of Rural Development (1978)
27. Kies, Constance and Fox, H. M. : *Cereal Chem.*, **47**, 615 (1970)
28. Klassen, A. J., Hill, R. D. and Larter, E. N. : *Crop Sci.*, **11**, 265 (1971)