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Optimum Conditions for Alkali Digestibility Test in Rice

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Alkali崩壞度檢定을 위한 最適條件에 對하여

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摘 要

白米의 alkali 붕괴도 검정에 필요한 최적조건을 구하기 위하여 test-tube miller를 사용하여 도정하고 25°, 30°, 35° 및 40°C의 온도에서, 1.4%에서 2.8%까지 8수준의 KOH 농도로 일정한 시간을 두고, Indica, Japonica 등 10품종을 사용하여 alkali 붕괴도 시험을 행하여, 본 검정에 영향을 미치는 白米의 도정 정도, KOH 농도, 처리온도 및 처리시간을 검토하였다. 그 결과를 요약하면 다음과 같다.

1. Test-tube miller에서 90분간 도정한 시료는 alkali검정에 적당한 도정도를 나타내었다.
2. Japonica와 Indica를 동시에 검정할 경우에는 1.8%의 KOH 농도에서, Japonica만을 검정할 경우에는 1.4% 혹은 그 이하의 농도에서, 또 Indica만을 검정할 경우에는 2.2%의 농도에서 각각 30°C, 18시간 동안 처리하는 것이 최적 조건으로 보였다.

ABSTRACT

Optimum conditions for alkali digestibility test of rice grain were examined. 90 minutes milled samples with test tube mill, 1.4%, 2.2% and 1.8% KOH solution for soft, hard and medium hard rice respectively at 30°C 18 hours were considered as optimum.

I. INTRODUCTION

Recent development of rice breeding in Korea have prompted us to investigate the quality problems. In general, Indica varieties have high amylose content, and not palatable for Koreans. So that, much concernings should be paid for the consumer's preference when the plant breeders want to make a new variety from the crosses of Indica and Japonica.

Alkali digestility test initiated by Warth and Darabsett[15] has been developed by many researchers[2,3,4,5,6,7,9,11] for the indirect estimation of gelatinization temperature which is known to be associated with the cooking quality.

However, the results obtained from the previous works were not coincident in the concentration of KOH. Therefore, it is very important for us to determine the optimum conditions for this test which is appliacble to our own materials by discussing all the factors, such as, milling degree of samples with a new-designed test-tube miller, the concentration of potassium hydroxide, the temperature, and the time for soaking.

II. MATERIALS AND METHODS

Experiment I. Determination of milling degree of samples for alkali digestibility test.

1. Materials and drying process: Rice samples of 6 varieties, CP231-SLO17, Century-Patna 231, Chianung 242, Jinheung, IR 262, and Palkweng were dried artificially in incubator at 25°C for 24 hours and 30°C for 24 hours successively. The dried samples were dehulled by Satake Sheller and milled with a newly designed test-tube miller. The specifications of the miller were shown in Table 1.

Table 1. Specifications of a new designed test-tube miller.

Specification	Descriptions
Motar HP	0.5
RPM	1750
Round/min.	250
Stroke	6.5 inch
No. of interchangeable test-tube box	2
Tube size	1.5×15.0cm
No. of test-tube	40
Scoring abrasive	aluminumoxide grain in 50 mesh

2. Milling procedure.

The milling procedure with a test-tube miller was followed by the method of Scott et al[13]. That is, after hulling, approximately two grams of samples and the same amount of scoring abrasive (aluminumoxide grain in 50 mesh) were placed in each test tube. The test tubes were mounted in the test tube block of the miller and milled for 30, 60, 90, and 120 minutes each. And the milled samples were removed from the tube and polished with cloth by removing the adhering particles of bran, germ, floury bit of endosperm and abrasive materials. Broken rice were passed to the sieve, and separated from the whole grain. The whole grains were used in this alkali digestibility test.

3. The procedure for alkali digestibility test.

Six kernels of each variety were spaced evenly in petri dish which contained 20ml of KOH solution of 1.7%, and each grains was investigated after 24 hours later from the initial soaking time in 30°C incubator.

The digestibility values of each grain were evaluated in according to a new established numerical scale in which the spreading and the clearing degrees are combined in one grade to simplify and to shorten the reading time in the test. The description of reading scale and the figure are shown in Table 2 and Fig. 1.

Table 2. Description of reading scales for evaluating the alkali digestibility.

Index	Degree of digestibility
1	Kernel chalky and a little affected or not
2	Kernel chalky and slightly swollen
3	Kernel swollen with a bursted belly and a narrow collar
4	Kernel swollen with a cloudy collar
5	Kernel disintegrated into a cloudy mass with chalky fragments
6	Kernel disintegrated, margining with a clear mass
7	All kernels completely dispersed into a clear mass

Experiment II. Determination of the optimum conditions for the alkali digestibility test.

1. Materials

Rice samples used for this experiment were derived from the same source of those in Experiment I and listed in Table 3. The same procedures were conducted in sample preparation as those of in Experiment I.

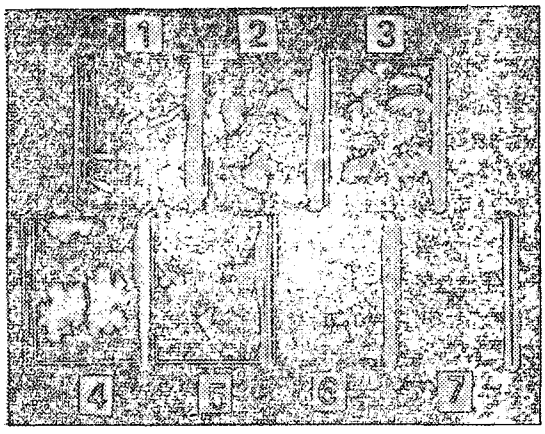


Fig. 1. Reading scales for alkali digestibility test of milled white rice.

Table 3. Varieties used in Experiment II.

Entry No.	Variety	Original Country	Varietal Group	Grain Appearance
0	Cp231-SLO17	U.S.A.	(Ind. x Jap.) × Ind.	Long
1	Century-Patna231	〃	Indica	〃
3	Dawn	〃	〃	〃
4	IR 262	Philippines	〃	Medium
5	Blue Belle	U.S.A.	〃	〃
6	Chianung 242	Taiwan	Ponlai Japonica	Short
7	Palkweng	Korea	Japonica	〃
8	Suwon 118	〃	〃	〃
9	Norin#6	Japan	〃	〃

2. Treatments

1) Concentration of KOH solution; Eight levels of diluted solution of potassium hydroxide, that is, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6, and 2.8%, were prepared from the 3% of stock solution by titrating.

2) Soaking time; The digestibility values were read at evey 3, 6, 9, 12, 18, and 24 hours later from the initial time of soaking.

3) Temperature; The test was coducted at the four levels of temperature, that is, 25, 30, 35, and 40°C in incubator.

3. The test procedure

Six kernels of each variety were spaced evenly in petri dish which contained 20 ml of KOH solution of each concentration. The dishes were covered and kept undisturbingly in each levels of temperature. Each kernel was evaluated in according to the seven-rank reading scale described in Table 2, and figured in Fig. 1. Two replications were carried out in conditions, and the values of each grains were averaged to represent the varietal digestibility in each conditions.

III. RESULTS

1. Milling degree of sample grain for the alkali digestibility test.

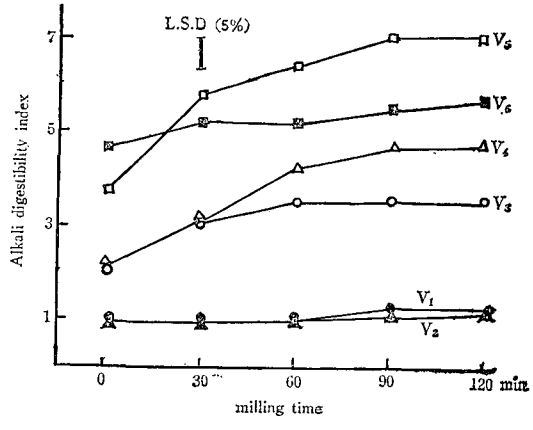
Milling degree of sample grain is expressed as weight percent of milled rice to that of brown rice. The results of milling degree obtained from the test tube miller and the changes of alkali digestibility value of each varieties at the different milling degree were shown in Table 4, and in Fig. 2.

Table 4. Milling degree at the different milling time with a new test-tube miller.

Variety	Milling Time(min.)				
	0	30	60	90	120
CP231-SLO17	100	92.3	92.3	91.0	91.0
Century-Patna	100	92.1	87.6	85.9	83.6
Chianung 242	100	89.7	89.3	87.7	87.7
Jinheung	100	92.3	91.9	89.8	89.4
IR 262	100	92.1	89.3	88.5	86.9
Palkweng	100	91.4	90.9	90.4	90.4

* Average of three replications.

The milling degree of each samples was increased



V_1, CP231-SLO17 V_2, Century Patna 231; V_3, Ch242; V4, Jinheung, V_5, IR262; V_6, Palkweng

Fig. 2. Changes in alkal digestibility value at the different milling time in the test-tube miller.

with increasing the milling time, and the varietal difference in milling degree was more typical than that of milling time as shown in Fig. 2. The samples milled for 60 minutes in this test-tube miller showed nearly 90 percent of milling degree in average.

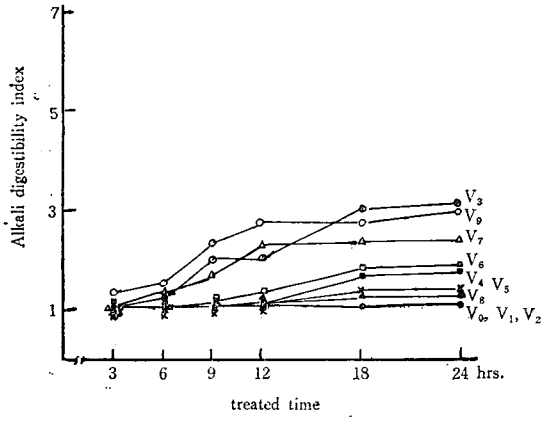
As shown in Fig. 2, the alkali digestibility value was increased along with the increase of milling degree. However, the patterns of change in the digestibility of each variety were different. But the stable values of the digestibility, which is considered to be an adequate milling degree for the alkali digestibility values are obtained from the samples milled for over 90 minutes with this test-tube miller.

2. Determination of the optimum conditions for the alkali digestibility test.

In general, the alkali digestibility values of each variety were increased with increasing the concentration of KOH solution, the temperature, and the length of soaking time.

Among 192 conditions conducted in this experiment, typical three cases would be enough to represent all the variable patterns of alkali digestibility that is the lowest, the highest, and the optimum condition.

1) Alkali digestibility value at the lowest condition(1.4%, 25°C)



V_0, CP-SLO17; V_1, Century-Patna 231; V_2, Dawn; V_3, IR 262; V_4, Blue belle; V_5, Ch242; V_6, Jinheung; V_7, Palkweng; V_8, Suwon 118; V_9, Norin 6

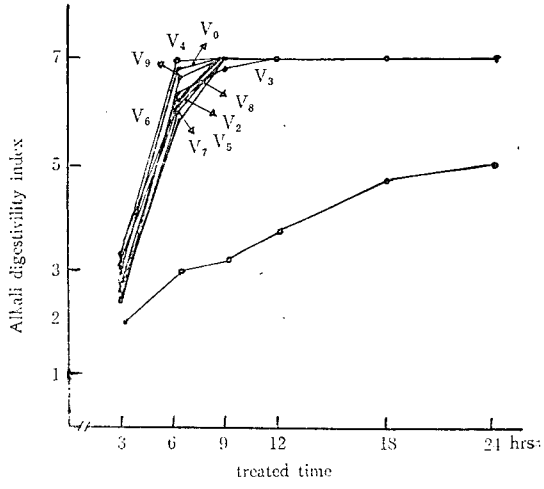
Fig. 3. Changes in alkali digestibility value at the different treated time in 1.4% KOH solution at 25°C.

At this condition, the digestibility value of each variety range from 1 to 3 even at the longest soaking hours, and the varietal differences were not distinguishable clearly as shown in Fig. 3. However, the values were sharply increased along the increase of the temperature from 25°C to 40°C even at the same concentration of KOH solution.

This leads us not to differenciate the varietal difference of the alkali digestibility value of each variety within the varietal group.

2) Alkali digestibility value at the highest condition (2.5%, 40°C).

At the highest concentration and temperature, the alkai digestibility values of each variety were too sharply increased within six hours, as shown in Fig. 4.



V_0, CP-SLO17; V_1, Centry-Patna 231; V_2, Dawn; V_3, IR 262; V_4, Blue Belle; V_5, Ch242; V_6, Jinheung; V_7, Palkweng; V_8, Suwon 118; V_9, Norin 6

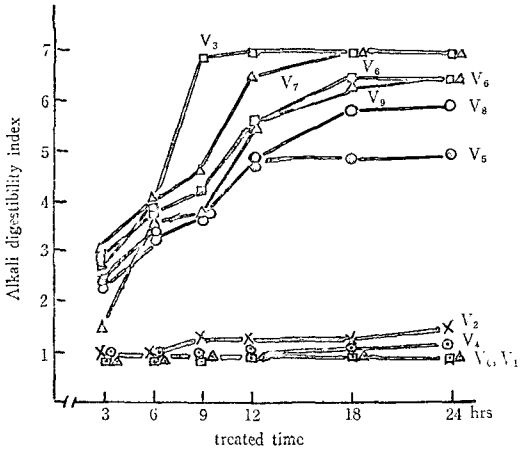
Fig. 4. Changes of alkali digestibility value at the different treated time in 2.8% KOH solution at 40°C.

However, it is remarkable that the responses of the most Japonica and Indica varieties to the alkali solution were not different each other in this extremely high condition.

3) The optimum condition for the alkali digestibility test.

The most distinguishable and stable condition for the test was obtained in the condition of 1.8%,

30°C, and for 18 hour-soaking as shown in Fig. 5.



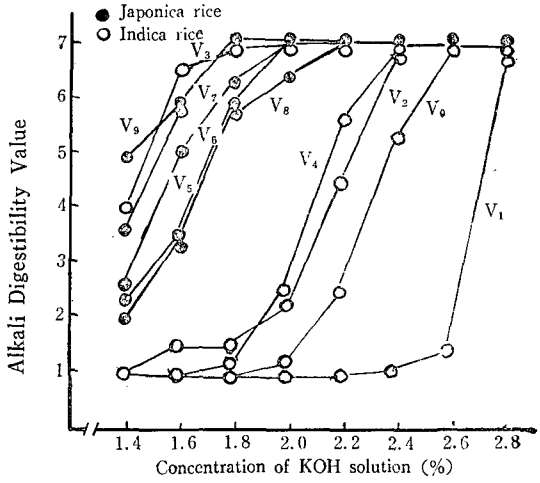
V_0, CP-SLO17; V_1, Century-Patna 231; V_2, Dawn; V_3, IR 262; V_4, Blue Belle; V_5, Ch242; V_6, Jinheung; V_7, Palkweng; V_8, Suwon 118; V_9, Norin 6

Fig. 5. Changes in alkali digestibility value at the different treated time in 1.8% KOH solution at 30°C.,

In this condition, two groups, that is, Indicas and Japonicas and/or hard and soft groups were critically devided, while the varietal differences of alkali digestibility within the group were not critically distinguished particularly in Indica varieties. So that, this condition will represent the optimum condition for the alkali digestibility test when both Indica and Japonica varieties are to be tested simultaneously.

When the varieties within the group are to be tested separately, another optimum conditions will be necessary for each group. For the most part of our investigation, the alkali digestibility values were changed more critically with changing the concentration of potassium hydroxide solution than with changing the temperature and soaking time. By fixing the temperature and soaking time to 30°C and 18 hours respectively, the critical concentration of KOH for alkali digestibility values in each varietal group showed the lower concentration of KOH solution within the range of 1.6% or below, the more distinguishable Japonica and/or soft varietal group was, and the higher concentration of KOH within the range of 1.4 to 2.2% KOH, the more distinguishable Indica and/or hard group was.

The critical concentration of KOH showing more distinguishable alkali digestibility in each varietal group were 1.4% or lower for Japonia and/or soft varietal group, and 2.2 percent for Indica and/or hard varietal group as shown in Fig. 6.



V_0, CP-SLO17 V_1, Century-Patna 231; V_2, Dawn, V_3, IR 262; V_4, Blue Belle; V_5, Ch242; V_6, Jinheung V_7, Palkweng; V_8, Suwon 118; V_9, Norin 6.

Fig. 6. Changes in alkali digestibility value at the different concentrations of potassium hydroxide solution.

Conclusively, the above mentioned condition of 1.8%, 30°C, and 18 hour-soaking represents the optimum condition for the simultaneous treatment of Indica and Japonica varieties, 1.6% or below for only Japonica and/or soft varieties, and 2.2% KOH for only Indica and/or hard varieties when the temperature and soaking time were fixed at 30°C, 18 hours.

IV. DISCUSSION

1. Milling degree of samples and alkali digestibility.

For the physico-chemical studies of rice grain, an accurate milling degree should be obtained before the samples are treated in the chemicals. As indicated by Beachell[3], however, the milling quality characteristics of rice grain are relatively easy to determine but require some special mechanical devices. Additionally, the sample in breeding pro-

genies is too limited to adapt the ordinary milling equipment for the sample milling.

The test tube miller used in this experiment designed from the authority of Scott et al[13] and Webb et al[14], was good enough to mill accurately the small quantity of samples, even though it cost much time and expense.

About the relatioship between milling degree of samples and the alkali digestibility value, Ramiah[12], and Beachell[1], Little et al[11], suggested that alkali digestibility value is to be affected by milling degree of samples. Ebata[3] confirmed that within the range of ordinary milling degree of 92 percent, under or over milling in slight extent did not considerably affect the decomposition degree of the kernels. He also pointed out that by scoring bran layers at the initial stage of the milling process. the alkali digestibility was abruptly decreased and abnormally high milled samples showed a progressively high susceptibility to alkali by the help of the high sensitivity of the inner layers of endosperm tissue. The result obtained from this experiment is somewhat agreeable to the results of Ebata[3].

2. Effects of concentration of potassium hydroxide, temperature and soaking time on the alkali digestibility value.

Many researchers have conducted the alkali digestibility test in their breeding program to evaluate the gelatinization temperature, while the conditions obtained from the previous works were different one another.

Jones[4] soaked milled rice in 2.38% solution of potassium hydroxide for 24 hours at room temperature, and Little et al[11]. treated the samples in 1.7 %, for 23 hours and evaluated the digestibility in two measurements, viz. spreading and clearing on the 7-rank numerical scales.

Ebata[3] noted that a clear differences between Japonica and Indica varieties were revealed, and he suggested that 1.4 to 1.5 percent for Japonica and 1.7 to 1.8 percent of KOH, for Indica varieties. Kihara et al[8] and Kurasawa et al[10]. recommended 1.7 percent KOH for 23 hours at room temperature for the inclusive test.

The main causes of the different results of previous works seemed to be the lack of consideration of all the factors, such as, milling degree of samples, temperature, soaking time and the concentration of KOH etc.

Our own results obtained from these experiments will be appropriated and good enough for the identification of varietal difference in alkali digestibility of rice grain, and enhance the speed of the test by combining the two measurements, spreading and clearing, into one measurement.

SUMMARY

In order to determine the optimum condition for the alkali digestibility test, the milling degree of samples, the concentrations of potassium hydroxide, the temperature and the length of time for soaking were discussed.

The results obtained from these experiments are summarized as follows;

1. Over 90 minute-milled samples in a new test tube miller showed the stable alkali digestibility values.
2. The optimum conditions for the alkali digestibility test were shown as 1.8 percent for the simultaneous treatment of Indica and Japonica varieties, 1.4 percent or below for only Japonica and/or soft group varieties, and 2.2 percent of KOH for only Indica and/or hard group varieties provided the temperature and soaking time were fixed at 30°C and 18 hours respectively.

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