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A Study on the Relationship between Cooking Properties of Adzuki Bean and Storage Conditions

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Adzuki bean (*Phaseolus angularis*) has been used for many cooking purposes in Japan. The basic method for adzuki bean cooking is heating in the presence of moisture, it seems that the differences of moisture content between the beans before cooking and between cooking methods have influence on the qualities of cooking products. But there is a general complaint about the poor cooking properties of these beans. Since the cooking properties depend, both on the moisture contents of bean before cooking and the cooking method. This investigation deals with the effect of storage conditions like relative humidity and temperature in the container, on the α -degree of starch, hygroscopic ratio and number of uncooked beans left after cooking. Results showed that water absorption of adzuki bean by soaking was very slow and took long time until saturation, temperature of water also influenced the absorption, and it was minimum at 5°C. One year stored beans showed the lowest absorption, skin at the germ part changed due to over drying during storage, the low water absorption and decrease of hygroscopic ratio resulting in the poor cooking properties of the bean. But starch of the bean could not change easily on the quality of paste. Numbers of uncooked beans, when prolonged stored beans were cooked, could be decreased by pressure cooking (2 kp/cm²).

INTRODUCTION

"An" (adzuki bean paste) is one of the typical traditional food in Far East countries, which is extensively being used in Japanese confectionaries for more than thousand years (Takei, 1969; Hatai, 1974, 1978). Recently, about 30 % of total "An" production is used in ice-cream industry in Japan and Korea. Generally "An" is prepared from adzuki bean (*Phaseolus angularis*), cowpea (*Vigna sinensis*) and kidney bean (*Phaseolus vulgaris*), but "An" prepared from adzuki bean is of the best quality as for aroma, color and taste are concerned.

Adzuki bean plant can not withstand frost, but high quality of adzuki bean can grow in the moderate zone (accumulated temperature about 1,000-L 100°C) (Nippon Mamerui Kikin Kyokai, 1974). At present, most of the adzuki bean are produced in moderate zone, which have better skin quality and aroma as compared with the "bean" produced in tropical region. Skin of the adzuki

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bean on near germ portion of seed differs from other kinds of beans in hygroscopic properties. Since water imbibing on the skin occurs only at germ, this characteristic affects the cooking quality of adzuki bean during storage. This study is to investigate the changes of cooking properties during the storage due to the change of high hygroscopic ratio and the seed size.

MATERIALS AND METHODS

Samples of Takara variety adzuki bean (*Phaseolus angularis*) grown in Minnesota (USA) and Hokkaido (Japan) in 1978 were collected, the beans were stored in different conditions, i. e., silo, storage room, living room (temperature : 20–22°C) and no air control room in the farm. Samples (A-H) in Fig. 2 used are fresh. Samples which are stored under the given storage conditions were examined for the hygroscopic ratio, moisture contents and α -degree of cooking properties were also measured according to the procedures described below.

1) Hygroscopic ratio was an increased ratio of weight per 100 grams of adzuki bean after soaking water for a fixed period of time. Moisture contents of adzuki bean was estimated at 105°C for 24 hr in a dryer.

2) α -degree of starch (ratio of gelatinization) of cooked bean was estimated by enzymatic method (Iwao, 1969). Cooking properties were examined by checking cooked adzuki bean condition in a steam pan. Chemical reagents were obtained from SIGMA Chemical Company (St. Louis, Mo. 63178, USA).

3) Humidity in a storage container was controlled by using saturated solution (Martin, 1962; Wexler and Brombacher, 1951; Wexler and Hasegawa, 1954). The following values were selected from the literatures interpolated to the temperatures mentioned against them : Lithium chloride – 12.4 % (20°C), magnesium chloride 33.6 % (20°C), potassium carbonate – 44.0 % (20°C), potassium nitrite – 49.0 % (20°C), magnesium nitrate – 54.9 % (20°C), sodium nitrite – 65.3 % (20°C), ammonium sulfate – 80.6 % (20°C), potassium nitrate – 93.2 % (20°C), potassium bichromate – 98.2 % (20°C).

RESULTS AND DISCUSSION

Physical properties and analytical data

Adzuki beans differ from soy bean due to higher carbohydrate contents (more than 50 % on dry basis), and they also contain about 20–28 % crude protein, therefore that is grouped into protein riches. Analytical and physical properties of adzuki beans are shown in Table 1. The thousand kernels weight of Japanese adzuki bean ranged between 100 – 120 g, whereas, Minnesota beans are a bit bigger in size and weighed around 150 g, resembling with “Japanese Dainagon”, and also fetch higher price.

Relationship between hygroscopic ratio and soaking time

Hygroscopic ratio (%) of adzuki bean is very poor as shown in Fig. 1. Especially the hygroscopic ratio just after soaking in cold water is very low and there is sharp increase in hygroscopic ratio after 10 hr of soaking. Log-

Table 1. Analytical data and physical data of adzuki bean.

Carbohydrate ¹⁾	56.7 (%)
Crude protein ²⁾	22.1 (%)
Ash	3.8 (%)
Lipid ³⁾	0.4 (%)
Fiber ⁴⁾	4.3 (%)
Moisture	11.0 (%)
Volumetrical weight	820 (g/liter)
Weight of 1,000 seeds	149.2 (g)
D e n s i t y	1.26 (g/cm ³)
Ratio between skin and endosperm	10.6 (%)

- 1) Phenol-sulfuric method.
- 2) Kjeldahl N \times 6.25.
- 3) Chloroform-methanol mixture (1 : 1).
- 4) From Iwao (1969).

arithmic curved line usually is seen as special about adzuki beans. Whereas, while soaking in warm water hydroscopic rate increases. After six months of storage, hydroscopic ratio of adzuki bean decreased about 1/8 of the fresh beans.

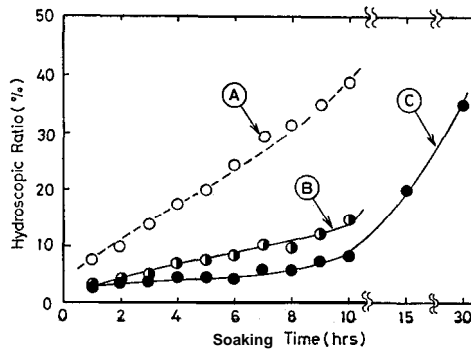


Fig. 1. Relationship between soaking time and hydroscopic ratio on different soaking temperature as follows: A = 20°C (fresh bean), B : 5°C (fresh bean), C = 20°C (bean stored for 7 months).

Relationship between water contents, hydroscopic ratio, and cooking properties

Water contents and hydroscopic ratio affected the cooking properties of adzuki bean to a large extent. Samples under different storage conditions are shown that cooking properties were highly correlated with hydroscopic ratio and water contents of adzuki bean. The bean with high moisture contents and high hydroscopic ratio showed better cooking properties (Fig. 2).

Relationship between relative humidity and moisture contents of adzuki bean during storage

Relative humidity during storage period had direct bearing on the moisture contents as shown in Fig. 3. Changes on the skin surface could be easily

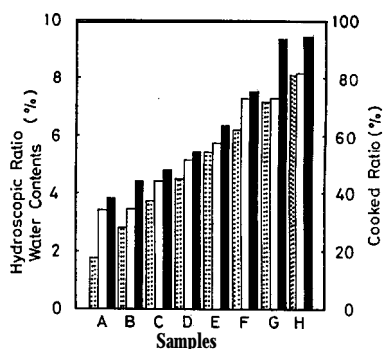


Fig. 2. Relationships among hydroscopic ratio, water contents and cooking properties on adzuki bean which were stored under different conditions. Everything was stored for three months at 20°C, relative humidity in the storage container was adjusted as follows: A = 12.4%, B = 33.6%, C = 44.0%, D = 54.9%, E = 65.3%, F = 80.6% and G = 98.2%, H is fresh beans. Dotted column: water contents, blank column : hydroscopic ratio, solid column : cooked ratio of adzuki bean.

detected after two weeks of storage, and little mold growth was observed after three weeks of storage under high humidity condition, whereas, a decrease in moisture contents was observed under low humidity storage. The storage test showed adzuki beans which were stored under dry conditions ("A" and "B") remained partially uncooked even after 90 min of cooking. Results showed that if moisture contents of adzuki bean during storage fall below 8 %, cooking properties were adversely affected.

A silo storage test under similar conditions as the farmers in Minnesota are actually used for storage of other grains in the farm showed that beans did not have any prominent change after six months of storage in the silo. A little change in moisture contents was observed, whereas cooking properties

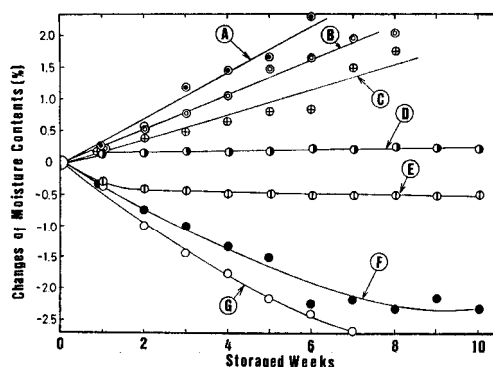


Fig. 3. Influences of relative humidity in storage container on water contents of stored adzuki bean. A = 12.4%, B = 33.6%, C = 44.0%, D = 54.9%, E = 65.3%, F = 80.6%, G = 98.2%.

remained unaffected, which might be attributed to the extremely cold winter season.

Influence of storage on cooking properties of adzuki bean

Storage conditions of the bean greatly affected the cooking properties as shown in Fig. 4. Fresh beans showed about 50 % starch α -degree when gelatinized after 60 min boiling and around 75 % after 90 min boiling. Whereas, the bean stored for more than one year showed only 18 % starch α -degree and it only up to 70 % after excessive cooking. The deterioration of cooking properties of adzuki bean after storage may be mainly due to the reason that germ portion in the seed which is the main water imbibing spot become inactive storage resulting from excessive moisture loss from the skin after storage. The deterioration of cooking properties was as shown in Fig. 4. The above conclusion was verified when comparison between the fresh bean scratched after storage was conducted on the basis of their cooking properties.

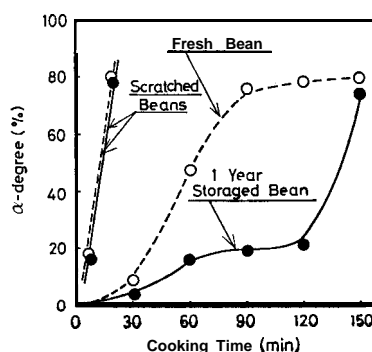


Fig. 4. Differences of cooking properties among fresh bean, one-year stored bean and scratched bean after being stored for one year.

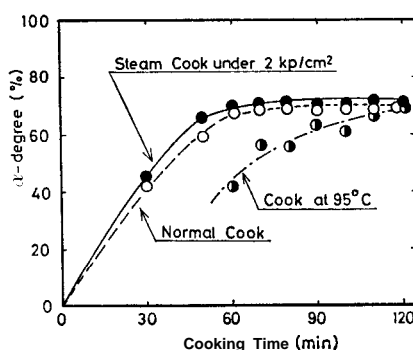


Fig. 5 Relationship between cooking time and α -degree of adzuki bean starch.

Results revealed that cooking properties after beans stored for one year were unaffected as the bean was scratched at germ before cooking, so it can

be safely concluded that cooking properties were affected mainly due to the loss of water imbibing spot (germ) after storage, and this defect can easily be overcome by providing other imbibing spot on the skin, simply by scratching. If moisture percentage of the bean, during storage fell below 6 %, the bean germination and cooking properties would be affected. Relationship between cooking temperature and starch α -degree is represented in Fig. 5. Boiling under 2 kp for 45min gives 70 % starch α -degree, which showed a 25 % cut in boiling time than that of normal cooking, whereas, cooking at 95°C prolonged boiling time to 120 min to get the same value of α -degree.

From the above results, fresh beans are the best materials for the preparation of "An" (adzuki bean paste), but there is no difference on cooking properties of which adzuki bean has been stored in the silo. Because atmospheric temperature is very cold after harvesting adzuki bean in Minnesota. Therefore adzuki bean has a high quality during all season in Minnesota.

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