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Cooking Properties of Some Korean Soybeans

Sung-Kon Kim and Jong-Goon Kim*
Department of Food Science and Nutrition, Dankook University, Seoul
**Department of Home Economics, King Sejong University, Seoul*

Abstract

Cooking properties of one variety(Bongui) and two cultivars(KW-12 and KLS-77005-1) were compared. Soybeans were presoaked in distilled water at room temperature for 16 hr and cooked in an autoclave at 106℃-121℃. The cooking rate was calculated by the maximum cutting force of the cotyledons. The cooking time for all cultivars were 150 min at 106℃ and 14 min at 121℃. The cooking rate constants were similar among cultivars. The z-value which was calculated from the time-temperature combinations that gave the same degrees of cooking for KW-12 was 13.1℃ and the others being 11.5℃.

Key words: soybean cooking

Introduction

Although soybean has been widely used in diet in Korea, its cooking property has not been extensively studied.

It was demonstrated[1-3] that the thermal softening of soybean follows a first-order equation. Quast and da Silva[2] utilized the time-temperature combinations to obtain z-value for softening of soybean. Kim *et al.*[3] reported that cooking rate of soybean could also be expressed by Arrehenius plot. Kim *et al.*[4] reported the hydration rate of black soybean at 80℃ and 100℃.

The purpose of this paper is to report our preliminary findings on the properties of some Korean soybeans. In the previous papers, chemical composition[5] and hydration property[6] were reported. In this investigation the cooking property is presented.

Materials and Methods

Materials

Three cultivars, Bongui, KW-12 and KLS-77005-1, were used in this experiment. The characteristics of these cultivars were described in the previous paper[4].

Corresponding author: Sung-Kon Kim, Department of Food Science and Nutrition, Dankook University, San 8, Hannam-dong, Yongsan-gu, Seoul 140-714

Cooking of soybean

Soybeans were soaked in three times of distilled water for 16 hr at room temperature. After removal of seed coat, the halved cotyledons were cooked with an autoclave, with come-up and come-down times maintaining 3 and 10 min, respectively. The cooked cotyledons were cooled in a running water for 1 min before texture measurement.

Texture measurement

The maximum cutting force of the samples was measured with Rheometer(Sun Co., Japan) as reported earlier[3], and an average of 20-30 measurements was expressed as g/g. A typical cutting force curve of cooked soybean cotyledon is shown in Fig. 1.

Results and Discussion

The reciprocal maximum cutting force was plotted against cooking time of soybean cotyledons at various cooking temperatures on logarithmic paper(Fig. 2). Each curve held a liner relationship, indicating that the cooking of soybean is the first-order reaction.

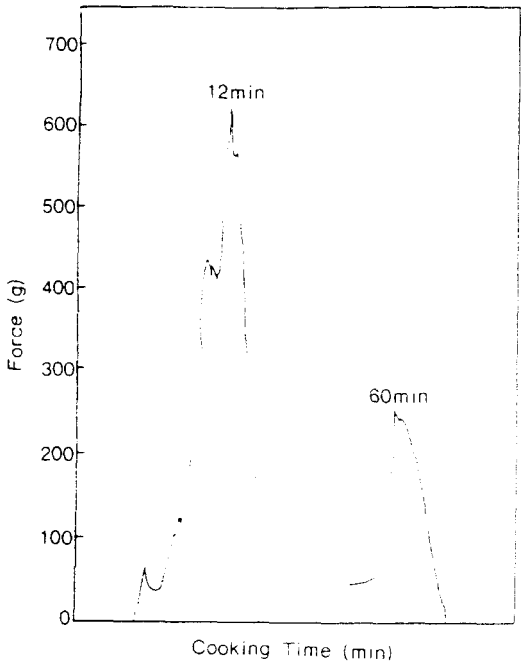

Fig. 1. Typical Rheometer curves of Bongui soybean cotyledon during cooking at 110°C

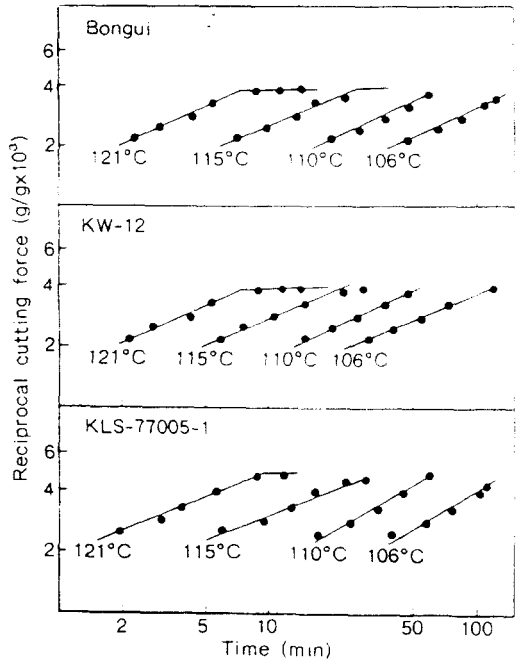

Fig. 2. Relation between the reciprocal cutting force and cooking time of soybean cotyledons at various cooking temperatures.

The cutting force was decreased as cooking time increased at the same cooking temperature but remained constant after a certain period of time. On the assumption that the cutting force in directly related to the degree of cooking, the bending point at each temperature(Fig. 2) was defined as the terminal point of cooking. The time to reach the terminal point of cooking was therefore assumed to be the cooking time at each temperature.

The cutting force and cooking time at the terminal point of cooking of soybean cotyledon are tabulated in Table 1. The cooking time at 121℃ for all cultivars was 14 min, which was comparable to that of previous result[3]. The cutting force of KLS-77005-1 cultivar was much lower than other cultivars.

The degree of cooking at each of temperature was calculated by the following equation[3]:

$$\alpha = \frac{C_t - C_o}{C_L - C_o}$$

where C_o and C_t are the cutting force at time 0 and t, respectively. C_L is the cutting force at the terminal point of cooking.

A plot of the rate of uncooked portion of soybean cotyledon as a function of cooking time in semilogarithmic paper is shown in Fig. 3. The rate of uncooked portion of cotyledon was linearly related to the cooking time, indicating that the cooking of soybean is a single-stage process. Sefa-Dedeh and Stanley[1] also reported that the thermal softening of soybean at 100℃ logarithmically increased as a function of cooking time. The cooking rate constants calculated from Fig. 2 are given in Table 2. The value of cooking rate constant was increased as cooking time elevated, but no significant differences were noted among soybean cultivars. Kim *et al.*[3] reported that the cooking rate constant was approximately doubled by increment of temperature by 5℃. The same trend was also observed in Table 2. It is worthwhile to indicate that the values for cooking rate constants reported by Kim *et al.*[3] should be lower-

Table 1. Cutting forces of raw and cooked soybean cotyledons and optimum cooking time at various cooking temperatures

Soybean	Cooking temperature (°C)	Cutting force (g/g)		Optimum cooking time (min)
		Raw soybean[a]	Cooked soybean	
Bongui	106	1,867	256	150
	110			70
	115			35
	121			14
KW-12	106	1,702	250	140
	110			60
	115			35
	121			14
KLS-77005-1	106	1,659	204	150
	110			60
	115			40
	121			14

[a]Soybeans were soaked in distilled water for 16 hours at room temperature prior to cooking

ed by one-tenth.

As evident in Fig. 2, the rate of uncooked portion at cooking time zero was not 1.0, which confirms the previous result[3]. It was reported[7,8]

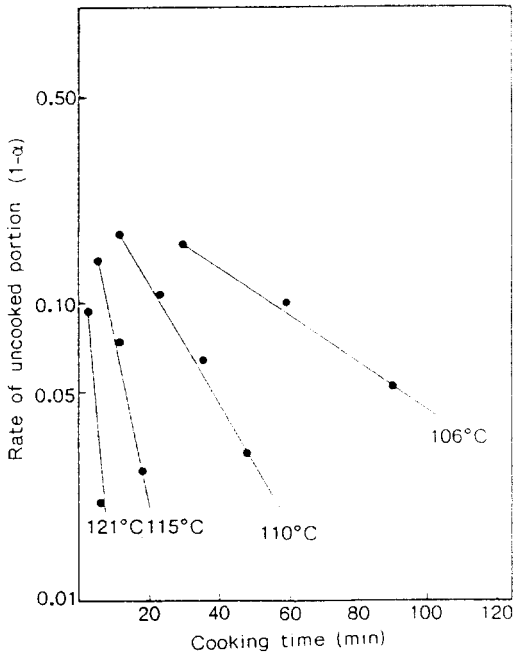

Fig. 3. The rate of uncooked portion of Bongui soybean cotyledon as a function of cooking time.

Table 2. Values of cooking rate constants of soybeans

Soybean	Cooking temperature (°C)	Cooking rate constant(min^{-1})
Bongui	106	0.0018
	110	0.0039
	115	0.0056
	121	0.0099
KW-12	106	0.0019
	110	0.0040
	115	0.0054
	121	0.0108
KLS-77005-1	106	0.0019
	110	0.0038
	115	0.0054
	121	0.0107

that the rate of uncooked portion of rice logarithmically decreased as a function of cooking temperature with intersect of 1.0 at cooking time of zero. The major constituent of rice is starch, while soybean has no or a little starch[9,10]. The result in Fig. 2 therefore may imply that the cooking process(or mechanism) of soybean may be different from that of rice. It was suggested[1] that the cooking of soybean would be influenced by the microstructure and chemical and/or physical changes occurring during hydration and cooking process.

The cooking times required to reach certain

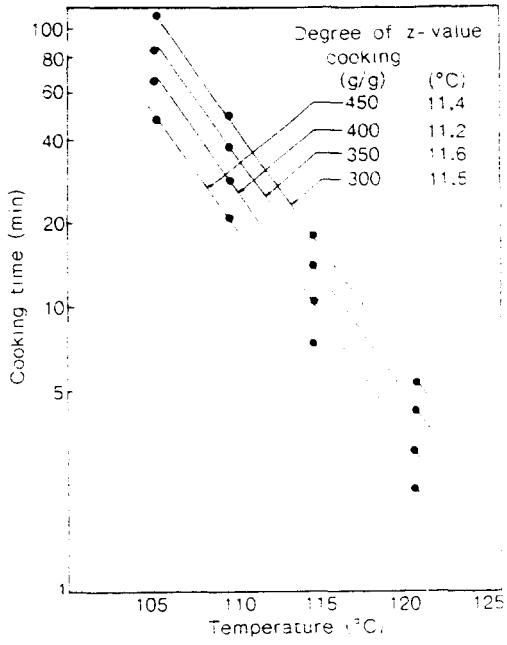

Fig. 4. Effect of temperature on the cooking time of Bongui soybean cotyledon.

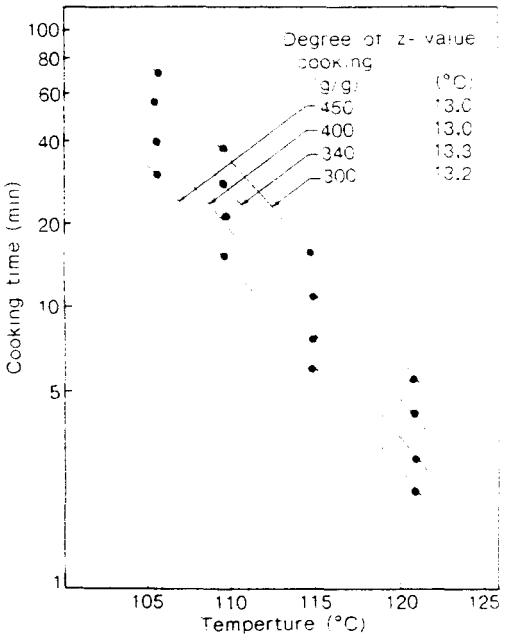

Fig. 5. Effect of temperature on the cooking time of KW-12 soybean cotyledon.

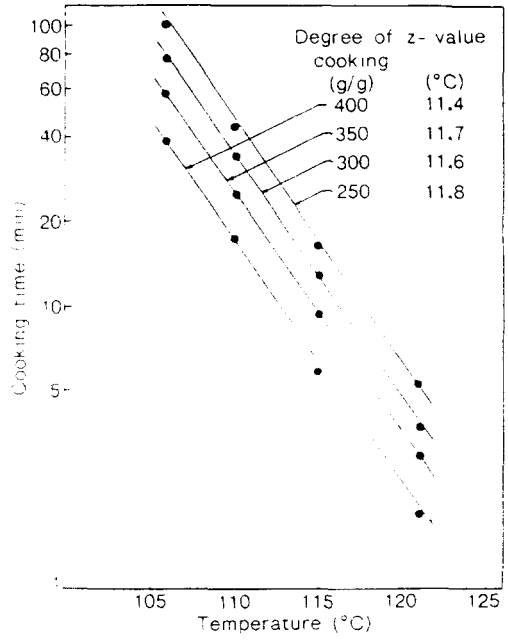

Fig. 6. Effect of temperature on the cooking time of KLS-77005-1 soybean cotyledon.

degrees of cooking at each cooking temperature were analyzed form Fig. 1 and the results are shown in Figs. 4-6. The straight lines in these figures represent the time-temperature combinations which give the same degree of cooking.

The slope of the curve is related to z-value[2]. As evident form Figs. 4-6, the z-values were essentially the same at different degrees of cooking. The average z-values for Bongui, KW-12 and KLS-77005-1 cultivars were 11.4°, 13.1° and 11.6℃, respectively. The reported z-values for soybean were 15.5℃[2] and 13.3℃[3].

Table 3. Temperature dependence of the cooking rate of soybean cotyledon

Soybean	Z (°C)	Ea (cal/g mole) at 106°C	110°C	115°C	121°C	Q_{10}
Bongui	11.4	57,900	59,200	60,700	62,600	7.53
KW-12	13.1	50,400	51,500	52,800	54,500	5.80
KLS-77005-1	11.6	56,900	58,100	59,700	61,500	7.29

The temperature dependence of the cooking rate of soybean can also be interpreted by apparent activation energy(Ea) or Q_{10} coefficient[2,3] :

$z = 4.6T^2/Ea$ or $\log Q_{10} = 10/z$

where T is the absolute temperature(K).

The results for the soybean cultivars are summarized in Table 3. KW-12 cultivar showed lower value for Q_{10} than others.

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우리나라 콩의 조리 성질

김성곤 · 김종군*

단국대학교 식품영양학과, *세종대학 가정학과

우리나라 콩중 장려품종(봉의)과 재래종(KW-12와 KLS-77005-1)을 106-121℃의 가압조건에서 조리하면서 최대 절단력을 측정하고 이로부터 조리속도를 분석 비교하였다. 시료콩 모두 106℃에서는 150분, 121℃에서는 14분 후에 조리가 완료 되었으며 조리속도 상수는 서로 비슷하였다. 일정한 조리도를 나타내는 온도-시간과의 관계로부터 구한 Z-값은 봉의와 KLS-77005-1가 11.5℃, KW-12가 13.1℃ 이었다.