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Effects of Cooking Time and HTST Air Dehydration Time on Physical Properties of Dried Green Peas

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Abstract

Effects of cooking time(5~30 min in a pressure cooker) and HTST air dehydration time(0~9 min at 150℃) on physical properties of dried green peas(3% moisture content, wet basis) were investigated by determining rehydration ratio, rehydration curve, browning reaction and puncture force. The rehydration ratio and curve of dried green peas were increased with increasing cooking time and HTST air dehydration time. Preheating of the green peas for 30 min in a pressure cooker, or for 9 min of HTST air dehydration time prior to 60℃ air dehydration recovered a 87.3% of original moisture content of raw green peas in a boiling water for 5 min. The browning reaction was gradually decreased up to 15min of cooking time. Puncture pressure of rehydrated green peas treated in a boiling water for 5 min was decreased, as the cooking time and HTST air dehydration time were increased, and was highly correlated with rehydration($r=-0.956$). The effects of cooking time and HTST air dehydration time on rehydration ratio, browning reaction and puncture pressure were significantly different at the $\alpha=0.01$ level except effect of HTST air dehydration time on browning reaction.

Introduction

Dry green peas and beans are commercially hydrated for 12~16 hr at room temperature prior to processing. Hydration was necessary to decrease cooking time and increase the drained weight[1,2].

Several researchers studied the effects of hydration rates on the quality of the product using chemical hydration mediums such as sodium chloride, sodium tripolyphosphate, sodium bicarbonate and calcium chloride, which had a direct influence to the color, drained weight and firmness of rehydrated beans[3-6]. The effect of hydravac process also facilitated infusion of solution through the helium and fissures in the hydrophobic out layer of seed coat for preparing quick cooking dry beans [7]. But, little research has been conducted to study the effect of processing parameters on physical properties of green peas. High pressure water cooking method had higher sensory attributes such as odor, flavor and sweetness of green peas than atmospheric pressure water cooking method[8]. According to the texture studies of green peas using a single puncture tester[9,10], the force required to puncture green peas was related to alcohol insoluble solids and total solids, while the organoleptic assessment of the texture of cooked peas was related to the hardness of the raw cotyledon.

The objectives of this study were to examine the effects of various of cooking times and HTST air dehydration times on physical properties of dried green peas.

Materials and Methods

Raw green peas

Green peas(*Pisum sativum* L.) obtained from the 1990 harvest were used in this study. The moisture content of the green peas was 75.40% on a wet basis.

Soaking, cooking and dipping

After soaking the green peas in water at room temperature for 16 hr, samples were cooked in a pressure cooker for 5, 10, 15, 20 and 30 min, and immediately dipped in 0.2% salt solution at room temperature for 5 min.

Air dehydration

After above pretreatments, green peas were exposed to air at 6 m/s and 150 ℃ for 3, 6, and 9 min in a cabinet drier with a 0.5g/㎠ tray load, and as the second stages of air dehydration, green peas were dried at 60℃ and 4 m/s air velocity to give a shelf stable final moisture content(3%, wet basis).

Green peas were also dried in a cabinet air drier at 60℃ and 4 m/s air velocity directly after pretreatments without HTST air dehydration.

Determination of moisture content

Moisture content was determined in a cabinet drier at 105℃ for 24 hr.

Determination of browning reaction

Browning reaction was determined according to the method of Hendel *et al*[11].

Determination of rehydration ratio and curve

Rehydration ratio was measured as the total mass of rehydrated green peas per unit weight of dry matter after rehydration. Ten grams of dried green peas were added to 100㎖ boiling water in a 200㎖ beaker, held for 5 min and drained through a Buchner funnel and weighed.

Rehydration curve was also determined by adding 10g dried green peas to 100㎖ boiling water for the desired time and drained immediately through a Buchner funnel and weighed.

Determination of puncture pressure

Puncture pressure was determined by a modification of Wager *et al* method[10]. A 1.0mm diameter rod was mounted on the crosshead of the rheoner (Yamaden, RE-3305) and the pressure required to penetrate an individual rehydrated green pea, 0.97~1.04㎝ of geometric diameter, positioned over a 3.0mm diameter counter-sink hole. The measurement was performed at the crosshead speed of 5 mm/s. The puncture pressure values reported were the mean values from seven determinations.

Results and Discussion

Effect of cooking time and HTST air dehydration time on rehydration characteristics

Effects of cooking time and HTST air dehydration time on rehydration ratio of dried green peas in a boiling water for 5 min are given in Fig. 1. The rehydration ratio of dried green peas was increased with increasing the cooking time. It might be due to the structure expansion during cooking of green peas, which made highest moisture gain after 30 min of cooking time. The effect of cooking time on rehydration ratio was also described as F-ratio(76.99) shown in Table 3, which was significantly different at the $\alpha=0.01$ level.

The amount of water absorbed by the HTST treated dried green peas was higher that of green peas dried directly at 60℃ through all cooking times. These facts indicated that HTST treated dried green peas open pores within the samples which facilitated water penetration during rehyd-

ration. Further evidence of more porosity in HTST treated dried green peas could be seen in the rehydration curve shown in Fig. 2. Preheating of the green peas for 30 min in a pressure cooker, or for 9 min of HTST air dehydration time prior to 60℃ air dehydration, recovered a 87.3% of original moisture content of raw green peas in a boiling water for 5 min, which had highest increase of moisture(1.93g water/g solid).

According to the preliminary experiments, above 150℃ of air temperature and 9 min of dehydration time made incidence of scorching or hardening of the surface in samples. The rehydration curve (Fig. 2) showed that the rehydration ratio in Fig. 1 may not be the maximum for all samples. It meant values of the rehydration ratio obtained at a point before the rehydration curve levelled off were good indices of the relative rate of rehydration and rehydration capacity between samples.

The effect of HTST air dehydration time on rehydration ratio was also significantly different at the $\alpha=0.01$ level as shown in Table 3.

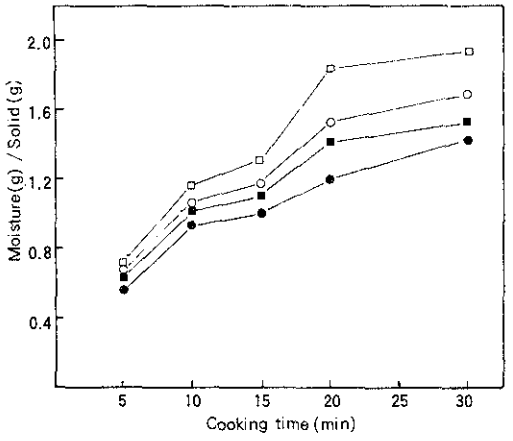

Fig. 1. Effects of cooking time and HTST air dehydration time on rehydration ratio of dried green peas which were rehydrated 5 min in boiling water.

●Direct air dehydration at 60℃
■3 min of HTST air dehydration at 150℃ prior to 60℃ of air dehydration
○6 min of HTST air dehydration at 150℃ prior to 60℃ of air dehydration
□9 min of HTST air dehydration at 150℃ prior to 60℃ of air dehydration

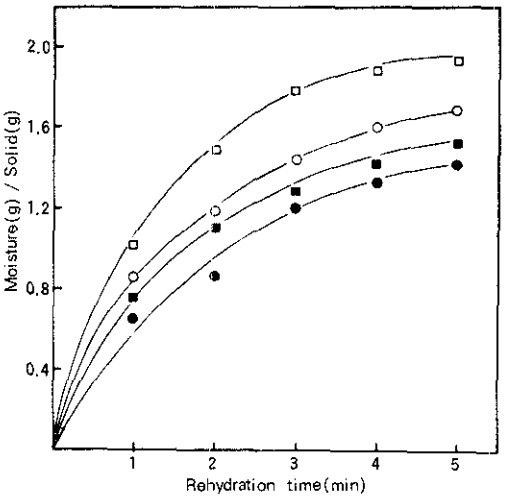

Fig. 2. Effects of HTST air dehydration time on rehydration curve of dried green peas in boiling water.

●Direct air dehydration at 60℃
■3 min of HTST air dehydration at 150℃ prior to 60℃ of air dehydration
○6 min of HTST air dehydration at 150℃ prior to 60℃ of air dehydration
□9 min of HTST air dehydration at 150℃ prior to 60℃ of air dehydration

Effects of cooking time and HTST air dehydration time on browning reaction

The O. D. value represented the browning reaction index of dried green peas, which was gradually decreased until 15 min of cooking time, but over 15 min cooking time, that of samples was increased as shown in Table 1. There was an initial brightening of the green color during the cooking within 15 min. But, further cooking over 15 min made the color of green peas gradually change from bright green to yellow green. These phenomena occurred owing to the loss of magnesium caused by the release of organic acids from green pea tissues, thus converting chlorophyll to pheophytin[12]. Generally, more than 50% conversion of

chlorophyll was necessary to change the color from bright green to yellow green[12]. It was also true for the cooking time on browning color development of green peas. Effect of cooking time on browning reaction of dried green peas was significant at the $\alpha=0.01$ level as shown in Table 3.

Even through samples undergo heat damage at high temperature dehydration process at 150℃, a 9 min of HTST dehydration treatment reduced dehydration time by 3 hr dried to 3% moisture content(wet basis) of green peas compared to that of direct air dried at 60℃. Eventually, the effect of HTST treatments on browning reaction of dried green peas was not significantly,different, as shown in Table 3.

Effects of cooking time and HTST air dehydration time on puncture pressure

Effects of cooking time and HTST air dehydration time on puncture pressure of green peas rehydrated in boiling water for 5 min were shown in Table 2. Maximum pressure of each sample corresponded to the rupture of the skin and the onset of permanent deformation of the upper cotyledon. The puncture pressure of rehydrated green peas was decreased with increasing the cooking time and HTST air dehydration time. Both structure expansion due to cooking treatments and more porosity due to HTST treatments, which made more water absorption during rehydration, contributed to these phenomena. Because, puncture pressure highly correlated with rehydration ratio, Y

Table 1. Effects of cooking time and HTST air dehydration time on browning reaction of dried green peas during air dehydration

HTST[1] air dehydration time(min)	Cooking time[2] (min) 5	10	15	20	30
0	0.018[3]	0.016	0.012	0.012	0.014
3	0.015	0.015	0.011	0.012	0.014
6	0.016	0.014	0.011	0.014	0.012
9	0.013	0.014	0.013	0.011	0.013

[1]Green peas were dried at 150℃.
[2]Green peas were cooked in a pressure cooker.
[3]Green peas were dried to 3% moisture content(wet basis) using a cabinet drier with 60℃ and units of represented data were O. D. at 420nm.

Table 2. Effects of cooking time and HTST air dehydration time on puncture pressure of rehydrated green peas in boiling water for 5 min

HTST[1] air dehydration time(min)	Cooking time[2] (min) 5	10	15	20	30
0	9.05 E6[3]	7.46 E6	5.86 E6	5.46 E6	5.06 E6
3	7.94 E6	7.20 E6	5.82 E6	5.32 E6	4.33 E6
6	7.91 E6	6.69 E6	5.84 E6	5.00 E6	4.22 E6
9	7.33 E6	6.02 E6	5.56 E6	4.05 E6	3.89 E6

[1]Green peas were dried at 150℃.
[2]Green peas were cooked in a pressure cooker.
[3]Green peas were dried to 3% moisture content(wet basis) using a cabinet drier with 60℃ and units of represented data were dyne/㎠.

Table 3. Analysis of variance for the effects of cooking time and HTST air dehydration time on the three responses

Process variables	Rehydration ratio	F-ratio Browning reaction	Puncture pressure
Cooking time	76.966** [1)]	15.457**	104.091**
HTST air dehydration time	15.440**	1.652 [N.S.2)]	14.925**

[1)] ** : Significant at the $\alpha=0.01$ level
[2)] N.S. : non significant

$=-3516652.56\ X+10.21\ E6$, $r=-0.956$), where X=rehydration ratio(g water/g solid), Y=puncture pressure(dyne/㎠). Cooking time had more influence to puncture pressure of rehydrated green peas than HTST air dehydration time, as shown in Table 3.

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조리시간과 고온 단시간 열풍건조시간이 건조완두콩의 물리적성질에 미치는 영향

김명환

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요 약

압력솥에서의 조리시간(5~30분)과 150℃의 고온 단시간 열풍건조시간(0~9분)이 건조 완두콩의 물리적 성질에 미치는 영향을 복원률, 복원곡선, 갈색화반응 및 puncture압력으로써 조사하였다. 복원률과 복원곡선은 조리시간과 고온 단시간 열풍건조시간이 늘어남에 따라서 증가되었다. 전처리로써 30분간 고온 단시간 열풍건조 시킨뒤 60℃에서 건조한 완두콩을 끓는 물에서 5분간 복원시, 생완두콩 수분의 87.36%를 회복하였다. 건조 완두콩의 갈색화 반응정도는 조리시간 15분까지 점차 줄어들었다. 끓는 물에서 5분간 복원시킨 완두콩의 puncture압력은 조리시간과 고온 단시간 열풍건조시간의 증가에 따라 줄어들었다. Puncture 압력과 복원률과는 매우 높은 상관관계를 가지고 있었다($r=-0.956$). 조리시간과 고온 단시간 열풍건조시간이 복원률과 갈색화반응 및 puncture 압력에 미치는 영향은 고온 단시간 열풍건조시간이 갈색화반응에 미치는 영향을 제외하고는 $\alpha=0.01$ 수준에서 모두 유의성 차이를 나타내었다.