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Physical properties of green soybean: Criteria for sorting

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Abstract

The objective of this research was to explore the possibility in developing a criteria for green soybean (Glycine max variety AGS 292) sorter. Green soybean could be classified into two main categories by its usage; the perfect pods (3-seed pod and 2-big seed pod) contained 47%, the rest was imperfect pods including 2-small seed pod, 1-seed pod, atrophied pod, twisted pod, and defected pod. Some important physical characteristics were investigated including width, length, thickness, pod weight, pod projected area, apparent density, bulk density, and seed firmness. The results illustrated that the perfect pods had length, pod weight, projected area and seed firmness significantly larger than the imperfect pods. All pod groups had apparent density equal or lower than water. Among all pod groups, the 2-big seed pods had the highest bulk density, thickest pod, and the firmest seed. The application of these physical properties for green soybean sorting was also proposed.

Keywords: Physical properties; Green soybean; Sorting

1. Introduction

Green vegetable soybean (*Glycine max*) or Edamame is a nutrient food crop, which gaining popularity throughout Asia and the United States (Sciarappa, 2005). It is a good source of protein and fiber and also has high minerals and vitamins (Eupan, 2003; Nutrition Division, 1987). Moreover, it contains isoflavones, which are also known for many potential health benefits including preventive effects on cancer, vascular disease, osteoporosis, menopausal symptoms, and cognitive function (Anderson & Garner, 1997; Sirtori, 2001; Umphress, Murphy, Franke, Custer, & Blitz, 2005). Approximately 80% of maturity fresh green pod are harvested (Shanmugasundaram, Cheng, Huang, & Yan, 1991; Song, An, & Kim, 2003). Its kernels have a sweet nutty flavor and can be taken as snack either boiled in salted water or roasted like peanut (Mentreddy, Mohammed, & Joshee, 2002). It can be also used in salads, soups, stir fry, or stews (Khudson, 2003) or make filling of desert.

The quality standard of green soybean for export is well defined by Japanese, the major importer and consumer. Because of a very high production cost, about 50% green soybean consumed in Japan mainly imported from China, Thailand, and Taiwan (Customs Department, Japanese Ministry of Finance, 2004; Eupan, 2003). The green soybeans are exported as frozen whole pods (blanched and dipped in salt solution) or frozen kernel. The pods quality accepted by Japan market is big pod, which is not less than 4.5–5 cm in length and has 2–3 seeds in a pod. In 500 g of green soybean sample must contain 2- or 3-seed pods not less than 175–180 pods. The pod is bright green without defect and without other color spot. The hair on the pod must be white or gray (Benziger & Shanmugasundaram, 1995; Sitatani & Vasi, 1992).

At present, the sorting process to meet the exporting standard is done manually. This step is high cost, labor intensive and must be performed quickly to reduce the

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quality loss. Therefore, the sorting machine is required. In order to design and develop suitable machine, physical properties of green vegetable soybean are necessary. However, the information of these properties has not been available. Therefore, the objective of this study is to investigate the physical properties of green soybean variety AGS 292, which is the major variety for export, and to propose the application of these properties for green soybean sorting.

2. Materials and methods

Green soybean (*Glycine max* variety AGS 292) was picked from the farmer field in Banglen, Nakhon Pathom, Thailand and from the Vegetable Center in Kasetsart University, Kamphaengsaen Campus, Nakhon Pathom, Thailand. The whole green soybean plants were picked and brought to the laboratory at Kamphaengsaen Campus to pluck the pods. Sample of 30 kg with five replicates were classified manually by experience workers into two main groups, perfect and imperfect pod. The perfect pods, which are premium quality for the whole pod having good typical shape and flesh green color include 3-seed and 2-big seed pods. These pods are mainly used for export. The imperfect pods, which are for peeled kernel or local consumption or waste, include 2-small seed pods, and 1-seed pods, atrophied pods, twisted pods, and defected pod. Each group was weighed and the proportion of total was calculated.

The physical properties including size, pod weight, projected area, apparent density, bulk density, and seed firmness were measured as the followings.

2.1. Size and pod weight

Six pod groups including 3-seed pod, 2-big seed pod, 2-small seed pod, 1-seed pod, atrophied pod, and twisted pod were measured for size (width, length, and thickness) (Fig. 1) by Vernier caliper and pod weight by electronic balance of 0.01 g sensitivity. Fifty pods for each group with six replicates were measured, except for the 1-seed pod, only 4–10 pods were used because it had the very small proportion.

2.2. Projected area

Four pod groups including 3-seed pod, 2-big seed pod, 2-small seed pod, and 1-seed pod were measured. Each pod was laid on a paper and the boundary line was traced to obtain a projected area. The area was measured by digital planimeter (Topcon model KP-90N, Japan). Fifty pods for each group were measured, except for the 1-seed pod, only 4–10 pods were used.

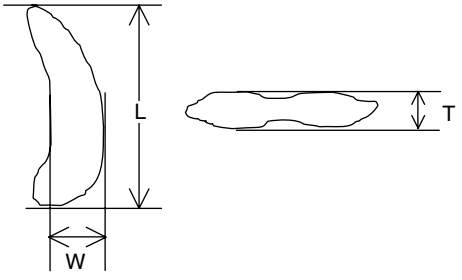

Fig. 1. Measurement of green soybean pod dimension. L = pod length, W = width, and T = thickness.

2.3. Apparent density

Each pod, which was measured for size, weight, and projected area, was weighed in water by piercing the sharp-ended stick into the pod and dip the whole pod just under the water surface in a beaker placed on the electronic balance. The procedure must be carried out fast to prevent water absorption into the pod. The apparent density was calculated by the following formula:

$$\text{Apparent density (g/cm}^3\text{)} = \frac{\text{Pod weight in air(g)}}{\text{Pod volume(cm}^3\text{)}},$$

when

$$\text{Pod volume (cm}^3\text{)} = \frac{\text{Pod weight in water(g)}}{\text{Water density(g/cm}^3\text{)}}.$$

2.4. Seed firmness

After the pods were measured for projected area, seeds of the 3-seed pods, 2-big seed pods, and 2-small seed pods were taken out to measure firmness using penetrometer (Chatillon, maximum force 1 kg_f, USA).

2.5. Bulk density

The samples of the 3-seed pods, 2-big seed pods, and 2-small seed pods were evaluated. The pods were put (without press) into a known volume container and were weighed. The bulk density was calculated by the following formula:

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Pods with container weight (g)} - \text{Container weight (g)}}{\text{Container volume (cm}^3\text{)}}.$$

2.6. Statistical analysis

The means and standard deviations of all properties were calculated. Means of the experimental data were compared by Duncan's multiple range test (DMRT) at 95% confidence of interval. The correlation coefficients among the properties were calculated.

3. Results and discussion

Marketable yield of green vegetable soybean are affected by number of seed per pod and pod weight (Kanika, 1999). Proportion by weight of different groups of green soybean is illustrated in Fig. 2. According to their usage, green