SUGAR CONTENT AS AFFECTED BY FRUITS SIZE AND SEED NUMBER OF SAPODILLA IN MADURA

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ABSTRACT

Sapota fruits are highly perishable due to their climacteric nature. The rapid softening of fruits is primarily due to high activity of many oxidative enzymes and liberation of ethylene. Harvest maturity plays a crucial role in deciding the marketability of climacteric fruits in general. We investigate sugar contents on sapodilla fruits related on fruits size and seed number. The experiment was conducted using 100 sapodilla fruits harvested from farmer in Madura. Fruit size and weight were recorded. Each fruit was separated into fruit and seed, and then weight was recorded with an analytical balance. The number and weight of seeds were counted. Total soluble solid (TSS; °Brix) was measured using arefractometer (PAL-1, Atago, Tokyo Tech). The number of seed and seed weight of sapodilla have correlation with Total Soluble Solid (TSS). The higher amount of seed equal with increasing seed weight, and effect to decrease TSS in sapodilla fruits. In additional, increasing seed weight have correlation with fruit weight, while TSS was decrease slightly. The average diameter and length of sapodilla fruit were 4.01 and 5.53 cm, respectively.

Keywords: fruit size, Sapodilla, TSS content, seed number.

INTRODUCTION

Chiku, a tropical fruit also known as sapodilla, belongs to the family Sapotaceae. Fruit of sapodilla (*Manilkara achras* Forsberg) is a native of tropical America and has been cultivated in most of the tropical countries for centuries (Sulladmath, 1983). The species most popular for its fruit in Southeast Asia is the *Manilkara zapota*. The sapodilla tree is evergreen, has a conical crown and can grow up to 30 m in height. The fruit is commercial for its flavour in sherbets, drinks, butter and ice-creams. It is also cooked to make pies, syrups, sauces, jams and is fermented to get wine or vinegar. In Indonesia, the young shoots are eaten either raw or after steaming with rice (Purohit and A. Singhvi, 1998).Sapodilla fruits are brown, round or oblong, with a thin skin. The flesh is sweet, soft and reddish-brown. The fruits have very few seeds in them that are hard, black, elongated, flattened and shiny.Sapodilla is usually consumed fresh.

Knee (2002), reported that appearance quality factors include size, shape, color, gloss and freedom from defects and decay. Flavor or eating quality depends upon sweetness (types and concentrations of sugars), sourness or acidity (types and concentrations of acids, buffering capacity), astringency (phenolic compounds) and aroma (concentrations of odor-active volatile compounds). When the fruit is ripe, the flesh is soft, pulpy and granular with a sweet and delicate taste (Broughton and Wong, 1979). Fruit are produced throughout the year but production is not uniform. As a single tree can bear hundreds of fruits, many are available at peak seasons. Unless optimal storage conditions are devised, many fruits are wasted. There is no

further information on the relationship between amount and size of seed, size and sugar content of sapodilla fruits in Indonesia. Hence, this study was undertaken to determine the sugar contents at different size of sapodilla fruit.

MATERIAL AND METHODS

The mature of 100 sapodilla fruits were collected from farmers garden in Bangkalan, were studied in November 2014. Fruits were picked hard, unripe but mature, which is the stage that is usually harvested. Sapodilla fruits were found to be climacteric with the respiratory peak occurring at the same time, or 1-2 days after peak ethylene production. Fruit size and weight were recorded. Width (transversal) and length (longitudinal) diameters was measured by calipers (Mitutoyo, Japan). Each fruit was separated into fruit and seed, and then weight was recorded with an analytical balance. The number and weight of seeds were counted. Total soluble solid (TSS; °Brix) were analyzed at Agroecotechnology Laboratory, Faculty of Agriculture, University of Trunojoyo Madura. TSS was measured using a refractometer (PAL-1, Atago, Tokyo Tech).Analysis of variance (ANOVA) was performed to test whether there were significant differences in fruit size (width or transversal and length or longitudinal) and sugars content. Means were compared using Duncan's Multiple Range Test. All statistical tests were carried out using SPSS version 16.0 (IBM SPSS Inc., Chicago) and differences with *p*-values less than 0.05 were considered significant.

RESULTS AND DISCUSSION

The number of seed and seed weight have correlation with Total Soluble Solid (TSS) (Figure 1). Sapodilla fruit from Bangkalan have number of seed around 1-7. The higher amount of seed, mean increasing seed weight, and give effect to decreased the TSS in sapodilla fruits. In additional, increasing seed weight have correlation with fruit weight, while TSS was decrease slightly (Figure 2). These changes in seed-yield werethe result of changes in the number of fruits per plant and thenumber of seeds per fruit. An increase in the sink, bothby an increase in the number or in the activity of the sinks,could cause an increment in the photosynthetic rate. Detected a direct negative relationship between the numberof seeds per fruit and seed-weight, and an indirect negative relationshipbetween the number of fruits per plant and seed-weightthrough the number of seeds per fruit. Stern *et al.* (2009), theincrease in fruit size was indicating that it is adirect result of increased sink strength. The number of seeds per fruit changed withsource-sink ratios. The effects among yield components (i.e.number of seeds per fruit and seed-weight and number of fruitsper plant and seed-weight) that could reduce selection progress forhigher seed-yield through the use of yield components as indirectcriteria.Seed-weight was the more stable yield component,a result that supports our prediction.Seed-weightshowed a high degree of homeostasis despite variation in assimilatesavailability (Masnattaa *et al.*, 2011).Fruit development and sugar content depend on sugaraccumulation and metabolism within the fruit. Sugar accumulationwithin a fruit, or translocation of photosynthate, is driven bythe sucrose concentration gradient from source to sink. When theamount in the source (leaves) is relatively large compared to thesink, the amount of translocation is dependent on the strength ofsucrose cleavage at the unloading site. Sweetness is one of the most important qualities of many fruits. One of the most important qualities of fruits is their sweetness, closely related to the soluble sugar content (Ozaki *et al.*, 2009). During the maturation, the total sugars content in sapodilla fruit from Bangkalan range from 14 to 27 °Brix.Brito *et al.* (2002) reported that the non-reducing sugars decreased from 5.6 to 1.0% and the reducing sugars increased from 9.3 to 12.5%, which is attributed to the sucrose inversion.Levels of glucose increased with progressive ripening, while the level ofstarch decreased in harmony with this. Ascorbic acid

contents alsoincreased with ripening, but fell when the fruits became over ripe (Broughton, *et al*., 1979). Photosynthetic carbon metabolism in higher plants is thought to be one of the important factors in soluble sugar synthesis, plant growth and fruit yield(Ozaki *et al.,* 2009).The sink strength of a developing fruit depends on both sinkactivity and sink size, which, in turn, depend on both the numberand the size of the fruit cells. If increase sink size at an early stage, the sink strength insubsequent stages will be enhanced and result in a sugarassimilation increase.At an early stageof fruit development, cell enlargement was resulting in higher sink size and sugar accumulation (Kataoka *et al.,* 2009). The average diameter and length of sapodilla fruit were 4.01 and 5.53 cm, respectively (Figure 3). The size of sapodilla in Bangkalan were smaller thanMexico that reported by Brito *et al.* (2001),the average diameter and length of the half-ripe sapota fruit were 7.5 and 6.4 cm, respectively. There was a greater increase in the length than in diameter during the change to mature. The fact that the length than the diameter was greater classifies the fruit more towards round in oval.Seed dry weight correlated better with fruit weight, than did seed number. Seed size varied for example with seed number, shading and flowering date, and such effects may account for the differences in the form of the relationship (Lawes *et al.,* 1990). In some vines, fruits that were small for their seed complement, had a lower mean seed weight, and mean seed weight was high in those fruits that were especially large for their seed number (Lawes *et al.,* 1990). Shaded fruits are smaller and contain smaller seeds, which may make them a poorer source of growth regulators and a weaker sink. Expansion of kiwifruit has been stimulated by growth regulators, and growth of fruit callus has been stimulated by growth regulators only in the presence of seeds (Lawes *et al.,* 1990). This may suggest a requirement for an unknown seed-factor for fruit growth, and some seeds may be more effective sources of such stimulatory substances (Lawes *et al.,* 1990).

For many species of fruit trees, size and sugar content of fruit are largely affected by partitioning of photosynthates (Kubota *et al.,* 1990; Teng *et al.,* 1999; Yamamoto, 2001). The sapodilla fruit from Bangkalan have varied largely frees weight range from 27 to 120 g. As sink organs, fruits are dependent on the translocation of sucrose, amino acids, and organic acids to the developing fruit cells; and the rate of import of these photoassimilates from the leaves is regulated by the metabolic activity of the fruit (Boggio *et al.,* 2000). Khalid *et al.* (2012) reported that the fruit quality of ‘Kinnow’ mandarin was different among tree age; fruit from 18-year-old trees were higher in total sugars, reducing sugars, acidity and total soluble solids than fruit from young trees (3-years-old). Moon *et al*. (2011) reporting that fruit diameter, fruit weight, pulp weight, and pulp thickness were higher in citrus fruits harvested from the top position of canopy than in the middle or bottom ones. Apart from tree age, fruiting position in canopy also plays an important role in determining fruit quality of ‘Kinnow’ mandarin which is different in the internal and external tree canopy in terms of juice mass (%), rind mass (%), rind smoothness and thickness (Khalid *et al.,* 2012).

We previously found that the quality of mangosteen fruit in terms of size and sugar content was higher in inner and bottom position of canopy (Setiawan *et al.,* 2012). Fruits of sapodilla take 10.5 months to complete maturity (Sulladmath, 1983). Sapodilla were found to be climacteric with the respiratory peakoccurring at the same time, or 1-2 days after peak ethylene production. The optimumstorage temperature was near 20 °C.Fruits ripened at 20-25°C had excellent taste. When the fruit is ripe, the flesh is soft,pulpy and granular with a sweet and delicate taste.Ascorbic acid and glucose levels increased with ripening but ascorbicacid decreased when the fruit became over ripe (Broughton, *et al*., 1979).

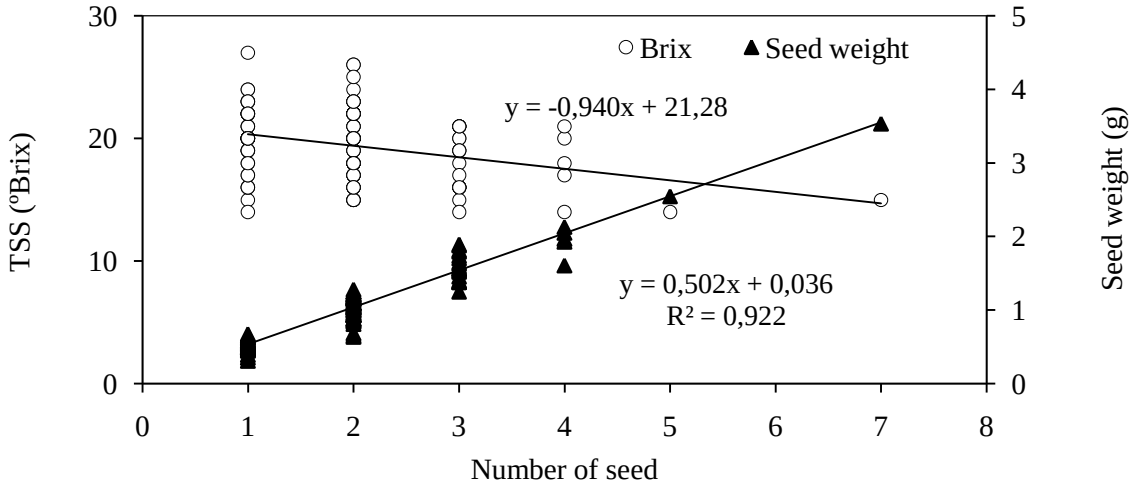

Figure 1. Relationship between number of seed, seed weight and TSS in sapodilla fruits.

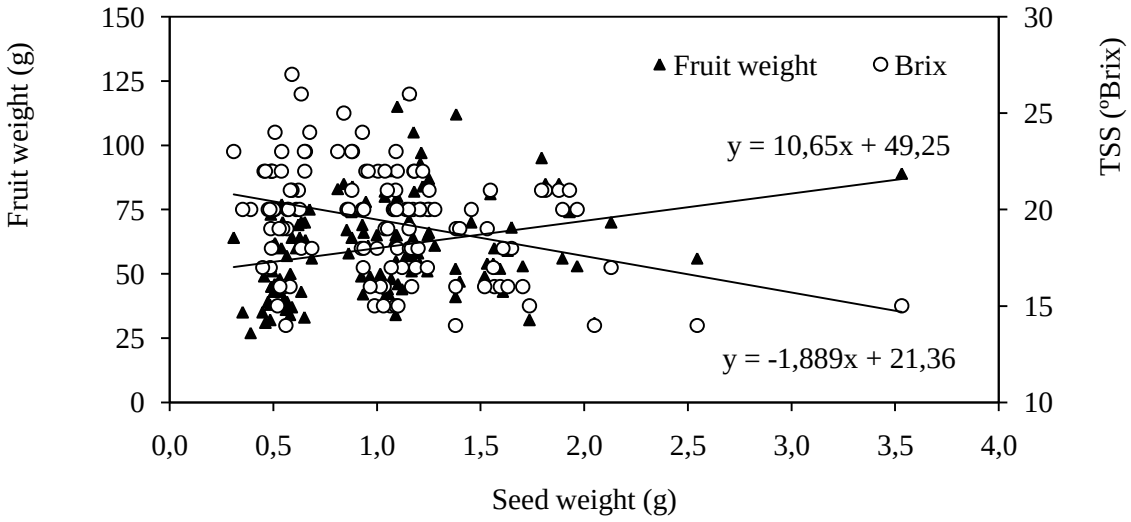

Figure 2. Relationship between seed weight, fruit weight and TSS in sapodilla fruits

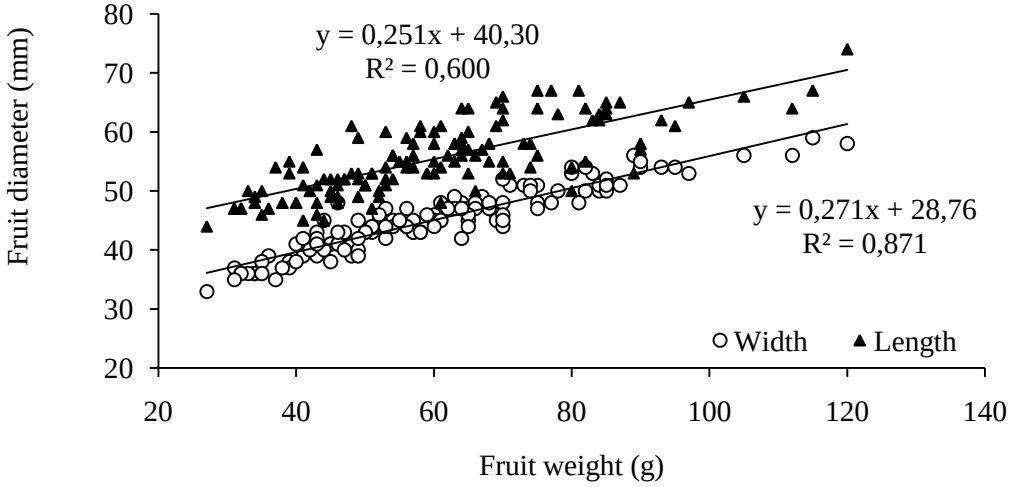

Figure 3. Relationship between fruit weight and fruit diameter in sapodilla fruits.

CONCLUSION

The number of seed and seed weight of sapodilla have correlation with Total Soluble Solid (TSS). The higher amount of seed equal with increasing seed weight, and effect to decrease TSS in sapodilla fruits. In additional, increasing seed weight have correlation with fruit weight, while TSS was decrease slightly. The average diameter and length of sapodilla fruit were 4.01 and 5.53 cm, respectively.

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