

EFFECT OF MATURITY STAGE ON PHYSICAL AND CHEMICAL CHARACTERISTICS AND DETERMINATION OF HARVEST TIME OF SUGAR SNAP PEA PODS

El-Seifi*, S.K.; M.A. Hassan*; R. E. I. El-Bassiouny; M.W.M. Elwan* and I.N. Nasef***

*** Department of Horticulture, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.**

****Vegetable Handling Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt.**

ABSTRACT

Two field experiments were carried out at the experimental station of the Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during the winter seasons of 2009-2010 and 2010-2011. The study aimed to investigate the effect of maturity stage on the nutritional quality and determination of the best maturity stage of sugar snap pea suitable for harvesting. Results showed that fresh weight of pods was increased and then decreased. Length and width increased until 48, 32 days after flowering (DAF), respectively, and then decreased. Dry matter and crude fiber increased while chlorophyll and vitamin C decreased during pod development. Sugar content and SSC increased and then decreased while phenolic content decreased, and then increased with maturation of pod. The obtained results showed that the best maturity stage is at 28 DAF.

Keywords: sugar snap peas, maturity stage, harvest, Ascorbic acid, fiber, total sugar, quality.

INTRODUCTION

Sugar snap pea (*Pisum sativum* L. var. *saccharatum*) is a newer type of peas. The modern sugar snap pea is the progeny of a cross between snow peas (*Pisum sativum* L. var. *macrocarpon*) and an unusual pea that was tightly podded with thick walls. The result is a pea that breaks or snaps like a green bean; the pods have thick walls, are sweet, and are edible (except for the strings). The sugar snap pea is allowed to mature and become fully rounded. The sugar snap pea has well developed seeds and is picked more mature and is fully rounded. Sugar snap peas should be harvested after they have developed seeds, similar to garden peas. Sugar snap peas differ from the traditional garden peas, as they have less fiber in the pods and it is eaten as whole tender pods without shelling. It may be eaten raw, lightly boiled, steamed or used in 'stir-frys'. It is known as edible podded peas because it does not have the same cross fiber in the wall of the pod as the common garden pea and can be eaten whole. It is sown for export as a vegetable, as well as, it plays an important role for human nutrition as a cheap source of protein, carbohydrates, vitamins, minerals and other nutrients.

To retain the best quality, edible-podded peas are harvested before physiological maturity is reached (Basterrechea and Hicks, 1991). Shortly after harvest, loss of sweetness and crispness, as well as degreening and the development of mealiness, may degrade the quality. Maturity at harvest is the

most important factor that determines postharvest-life and final quality i.e.; appearance, texture, flavor, nutritive value of fruit-vegetables. For immature vegetables such as sugar snap peas, the optimum eating quality is reached before full maturity and delaying harvesting results in lower quality at harvest and faster deterioration rate after harvest. Harvesting at the proper stage of maturity is essential for optimum quality and often for the maintenance of this quality after harvest. No information is available in the literature about the change in nutritional quality during the growth cycle and proper harvest stage of sugar snap peas. Accordingly, the objectives of this study are to provide information on the effect of harvest time on the nutritional quality and determination of the best maturity stage of sugar snap peas suitable for harvesting.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Research Farm, Faculty of Agriculture, Suez Canal University, Ismailia Governorate, Egypt, during the two successive winter seasons of 2009-2010 and 2010-2011 (from October 11, 2009 to March 14, 2010 and repeated on October 2, 2010 to March 5, 2011) to investigate the effects of maturity stage on the nutritional quality and determination of the best maturity stage of sugar snap peas (*Pisum sativum* L. var. *saccharatum*) cv. 'Super sugar snap' suitable for harvesting. Seeds were sown on October 11, 2009 and on October 2, 2010 for the two seasons, respectively. Seeds of sugar snap peas were sown at 10 cm within row and 1.00m between rows, under drip irrigation system and the recommended cultural practices were followed. Soil texture was sandy (85.21% sand, 3.29% clay and 11.5% silt), pH was 8.27, EC was 0.47 dSm⁻¹, Ca was 0.8 meq-1, Mg was 0.6 meq-1, K was 0.3 meq-1, Na was 3.0 meq-1, HCO₃ was 1.6 meq-1, Cl was 3.0 meq-1 and SO₄ was 0.1 meq-1. To obtain samples of pods of uniform maturity, blossoms were labeled with coloured tags. The dates of tagging were December 20, 2009 and December 9, 2010. Hand-harvesting of pods commenced 8 days after labeling and serial sampling was done at 4 days intervals. Final sampling was taken at 52 days after labeling. Samples were collected in the morning between 7:30 and 8:00AM.

Recorded data: The following physical and chemical parameters were determined during pod development:

1. Physical parameters: Twenty one pods were harvested and divided into three replicates each one contains 7 pods then average weight, length and width of the pods were measured.

2. Chemical parameters

2.1. Total Chlorophyll and carotenoid contents: Total chlorophylls and carotenoids were determined, spectrophotometrically, using acetone as a solvent, according to Lichenthaler and Wellburn (1983), and then calculated as mg/100 g fresh weight.

2.2. Titratable acidity %: Acidity was determined as citric acid according to Pearson (1970).

2.3. Soluble solids content (SSC): Soluble solids content was determined by hand refractometer according to A.O.A.C. (1996) expressed as °Brix at 20 °C.

2.4. Crude fiber %: Crude fiber was determined as percentage according to **Maynard (1970)**.

2.5. Dry matter: The percentage of dry matter content was determined by drying fresh pods in an oven at 70°C until constant weight was obtained. The results were calculated as percentage of fresh weight.

2.6. Ascorbic acid was determined by the titration method using 2,6-dichlorophenolindophenol according to **Pearson (1970)**.

2.7. Sugars content:

a) Total sugars were measured with phenol–sulfuric acid reagents spectrophotometrically at 480 nm according to *Dubois et al.*, (1956).

b) Reducing sugars were measured with alkaline copper and arsenomolybdate reagents spectrophotometrically at 540 nm according to **Moore (1974)**.

c) Non reducing sugars were determined by the difference between total sugar and corresponding reducing sugar value. Glucose was used as standard for sugar estimation.

2.8. Total phenolic content: Total phenolic determination was carried out for pods according to Mazumdar and Majumder (2003).

Statistical analysis: Data were organized in a completely randomized block design (CRBD) with simple design, with three replications, in which each replicate was considered as a block. Experimental data were statistically analyzed using Co-Stat version 6.303 1998-2004 CoHort software 798 Lighthouse Ave PMP 320, Monterey, CA, 93940, USA. Analysis of variance (ANOVA) was performed to compare results. Least significance difference (LSD) test was used to compare means at the 5% significance level.

RESULTS AND DISCUSSION

Physical parameters: Results of the influence of maturity stage on average weight, length and width of pods were recorded in table (1). Rapid increase in average fresh weight, length and width of pods occurred during early growth from 8 to 12 days after flowering (DAF). Fresh weight, after this stage, was increased continually until 44 DAF and then it was gradually decrease, in the first season while it was increased until 48 DAF, then decreased, in the second season. The early increase in fresh weight of the pods was almost entirely due to the growth of pods which reached their maximum weight then decreased due to losing moisture during ripening. The obtained results are in harmony with the results of Bisson and Jones (1932) on garden peas and Watadal and Morris (1967) on snap bean.

Length of pods rapidly was increased from 8 to 12 DAF then increased gradually from 16 to 48 DAF, in both season. Data also indicated that changes in length of pods were limited during the period 24 to 44 DAF, in the second season. Maximum length was reached after 48 DAF. This

increase may be due essentially to enlargement of the fleshy endocarpas reported before by Watadal and Morris (1967) on snap bean. The suitable harvest time for snap peas was reported to be when length of pods ranged from 6.4 to 7.6 cm (Hocking 1997). Width of pods was quickly increased from 8 to 12 DAF then increased gradually from 16 to 32 DAF then decreased until 52 DAF. Maximum width of pods was reached after 24 DAF, in the first season and after 28 DAF, in the second season.

Table (1): Average of weight, length and width of pod at different maturity stages during 2009-2010 and 2010-2011 seasons.

H*. Date (days)	2009-2010			2010-2011		
	Weight (g/pod)	Length (cm)	Width (cm)	Weight (g/pod)	Length (cm)	Width (cm)
8	0.64 i	3.70 h	0.80 f	0.53 j	3.60 g	0.80 e
12	2.04 h	5.77 g	1.27 e	1.44 i	5.23 f	1.17 d
16	2.87 g	6.47 f	1.43 d	2.27 h	6.20 e	1.40 c
20	4.62 f	7.30 de	1.60 c	3.20 g	6.53 d	1.57 b
24	6.53 e	7.40 c-e	1.77 a	4.67 f	6.87 c	1.67 ab
28	7.43 d	7.27 e	1.70 ab	5.92 e	7.27 b	1.70 a
32	7.66 cd	7.53 bc	1.77 a	6.07 de	7.07 bc	1.70 a
36	8.05 c	7.50 b-d	1.67 bc	6.59 d	6.97 bc	1.63 ab
40	9.29 ab	7.6 a-c	1.70 ab	8.24 c	7.20 b	1.57 b
44	9.74 a	7.57 bc	1.67 bc	8.49 bc	7.23 b	1.60 ab
48	9.65 a	7.80 a	1.63 bc	9.50 a	7.90 a	1.57 b
52	8.90 b	7.70 ab	1.63 bc	8.85 b	7.73 a	1.63 ab

Values are the means of 3 replicates each with 7 pods. Values followed by the same letter within a column are not significantly different at the 0.05% level of probability according to LSD test. H*= Harvesting

Chemical parameters: Results in table (2) show contents of soluble solids contents (SSC), vitamin C and titrable acidity in pod at different maturity stages. It is obvious from such data that maturity of pods influences SSC, vitamin C and acidity. Soluble solids contents was increased gradually until 36 DAF then decreased in pods during both seasons. Similar trend was obtained by Moneruzzaman *et al.* (2008) on tomato, and Sturm *et al.* (2003) and Ornelas-Paz *et al.* (2013) on strawberry. Similarly, soluble solids increased continuously during blackberry fruits development (Tosun *et al.*, 2008). The obtained results may be due to the fact that the content of SSC is a function of several factors as total sugars, so this increase in SSC during maturity stage perhaps due to increase in total sugar (Sturm *et al.*, 2003). The results show that vitamin C was decreased continuously during pods development from 8 to 52 DAF in both seasons, although some changes were not statistically significant. Similarly, Lee *et al.* (1982) reported that large and more mature peas contained less ascorbic acid than smaller and immature peas. Also, Hoover (1952) on southern peas found that vitamin C was content decreased with maturity on a dry weight basis from 135 mg per 100g on the 10th day after flowering to 15 mg per 100g on the 20th day. This decrease in vitamin C may be due to biochemical oxidation (Vendramini and Trugo, 2000), and to the increase in growth of pods (Nagy, 1980). With regard to titrable acidity, as shown in table (2) acidity increased in pod until 40 DAF then decreased, in both seasons. Similar findings have also been observed in strawberry by Ornelas-Paz *et al.* (2013).

Data recorded in table (2) show the content of chlorophyll a, b and carotenoids in pods at different maturity stages. In general, the obtained data indicated that chlorophyll a, b and carotenoids declined continuously during pod development stages with a sharp reduction from 8 to 16 DAF, and then a gradual decrease was noticed. There was no significant difference between stages from 16 to 24th day in both seasons for chlorophyll a and from 16 to 28th day in the first season for chlorophyll b and from 20 to 28th day in the second season for chlorophyll b. Similar trend was found for ambarella by Ishak *et al.* (2005) who indicated that total chlorophyll content was 0.56 mg/100 g in green fruits, 0.43 mg/100 g in half-ripe and 0.38 mg/100 g in ripe fruits. This decrease probably attributes to degradation of chlorophyll during pod development. During maturation process of the fruits, the chlorophyll content was decreased as a consequence of a process of biodegradation catalyzed by the chlorophyllase enzyme. In the first stage, the hydrolysis of the phytol takes place and in the second one, the porphyrinic nucleus decomposes liberating magnesium (Fleancu, 2007).

Dry matter and fiber content in pod at different maturity stages are presented in Table (3). The results show that dry matter was increased continuously during pods development. These results are in harmony with those of Bisson and Jones (1932) on peas. The increase in the percentage dry matter after 44 DAF must have been due to the loss of water accompanying ripening. Regarding fiber, the results illustrated that crude fiber in pods continuously increased during maturity stages. This trend is similar to that reported before by Bisson and Jones (1932) on peas and Hoover (1952) on green beans. The fiber content of the side wall is the most important constituent which influences the edible quality of sugar snap peas. Fiber in pod was increased rapidly until 28 DAF and increased slowly till 52 DAF. The obtained results are also in agreement with Bisson and Jones (1932). The increase in fiber contents from 40 to 52 DAF in pod may be due to transferring carbohydrates to crude fiber in the pods. So, harvesting sugar snap peas at the 28th day is the best maturity stage which has low fiber content, based on the condition of our experiment.

The results illustrated in table (3) present the content of sugars (total, reducing and non-reducing) in pods at different maturity stages. Total sugars and reducing sugars in pod increased until the 36th day then decreased after in both seasons, while non-reducing sugars increased until the 40th and the 28th days in the first and second season, respectively, then decreased up to 48 DAF. At 52 DAF the highest non-reducing sugars was observed in both seasons. The gradual increase in sugars content found in this study is consistent with the result of Bisson and Jones (1932) on peas. The obtained results are also in agreement with the results of Montero *et al.* (1996) who found that the content of glucose and fructose in ripening 'Chandler' strawberry fruit was increased continuously during 35 days after fruit set and decreased after 42 days from fruit set, while sucrose content was increased continuously until 21 to 28 days after fruit set and then decreased gradually during the rest of the ripening process. The increase in total sugar content might be due to conversion of starch into sugars (Moneruzzaman *et al.*, 2008).

As shown in table (3), the highest phenolic content value was at the 8th day in both seasons, and then decreased up to the 36th and the 32nd days in the first and second seasons, respectively. After that, total phenolic content again increased slightly until the 52nd day in both seasons. Similar findings have been reported by Fawole and Opara (2013) who reported that total phenolic content was 2027 mg/100ml at the early immature stage, 550mg/100ml at the half ripe stage and 583.72mg/100ml at the full-ripe stage of pomegranate fruits. Ishak *et al.* (2005) also reported similar trend of results in ambarella fruits. The decline in phenolic contents probably attributes to the oxidation of phenolic compounds by polyphenol oxidase during fruits maturity (Amiot *et al.*, 1995).

CONCLUSION AND RECOMMENDATION

The results of two experiments indicated that the best maturity stage to harvest sugar snap pea pods is 28 days after flowering because at that time the pods have high quality features such as low crude fiber, dry weight percentage as well as length and width of pods are proper for consumers and SSC, vitamin C, sugars and phenolic are still high.

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تأثير مرحلة النضج على الخصائص الفيزيائية والكيميائية و تحديد موعد الحصاد لقرون البسلة السكرية المتقصفة

سمير كامل الصيفى*، محمود عبدالمحسن حسن*، راوية البسيونى إبراهيم**
محمد وصفى محمد علوان* و إبراهيم ناصف ناصف*

* قسم البساتين- كلية الزراعة - جامعة قناة السويس- الإسماعيلية - مصر.

**قسم بحوث تداول محاصيل الخضراوات- معهد بحوث البساتين - مركز البحوث الزراعية- الجيزة - مصر.

تم إجراء هذه التجربة فى مزرعة كلية الزراعة جامعة قناة السويس بالإسماعيلية خلال موسمى الزراعة ٢٠٠٩-٢٠١٠م و ٢٠١٠-٢٠١١م و ذلك لدراسة تأثير مراحل النضج المختلفة لقرون البسلة السكرية المتقصفة صنف سوبر شوجر سناپ على تطور النمو و المحتوى الكيماوى للقرون و كذلك تحديد أفضل مرحلة نضج مناسبة للحصاد. و لقد أوضحت النتائج أنه زاد وزن القرن مع تقدمه فى العمر ثم انخفض فى المراحل المتأخرة من نضجه. زاد طول القرن و عرض القرن حتى ٤٨ و ٣٢ يوماً بعد الإزهار على التوالى ثم انخفضا بعد ذلك. زاد كل من المادة الجافة و محتوى الألياف بينما انخفض كل من محتوى الكلورفيل و حامض الأسكوربيك مع نمو القرن. زاد كل من محتوى السكريات و المواد الصلبة ثم انخفض بينما انخفض محتوى الفينولات ثم زاد مع نمو القرن و تطوره فى العمر. وقد اتضح من النتائج أن أفضل مرحلة للحصاد عندما تكون القرون فى عمر ٢٨ يوماً بعد الإزهار.

قام بتحكيم البحث

كلية الزراعة – جامعة المنصورة
مركز البحوث الزراعية

أ.د / سمير طه العفيفى
أ.د / عبد الله حلمى على

Table (2): Content of SSC, vitamin C, acidity, chlorophyll a, b and carotenoids in pod at different maturity stages during 2009-2010 and 2010-2011 seasons.

H*. Date (days)	2009-2010						2010-2011					
	SSC Brix	Vitamin C (mg/100 g FW)	Acidity %	Chlo. a (mg/100 g FW)	Chlor. b (mg/100 g FW)	Carot. (mg/100 g FW)	SSC Brix	Vitamin C (mg/100 g FW)	Acidity %	Chlo. a (mg/100 g FW)	Chlor. b (mg/100 g FW)	Carot. (mg/100 g FW)
8	7.50 fg	117.30 a	2.62 f	17.28 a	8.04 a	18.74 a	8.33 g	167.22 a	2.57 g	13.92 a	8.79 a	18.67 a
12	7.17 g	131.01 a	2.63 f	11.27 b	5.49 b	11.18 b	8.33 g	131.79 b	2.67 fg	10.87 b	7.55 b	15.44 b
16	7.17 g	84.50 b	2.76 f	6.58 c	3.66 c	10.99 bc	8.67 g	89.81 c	2.75 e-g	6.79 c	3.91 c	11.35 c
20	7.90 f	72.93 bc	4.28 cd	6.24 c	2.90 cd	10.11 cd	9.43 f	78.94 d	2.86 d-g	6.45 c	3.12 d	10.45 cd
24	8.57 e	68.39 b-d	4.31 b-d	6.04 c	2.74 c-e	9.37 de	10.20 e	70.00 e	3.15 c-f	6.23 c	2.94 de	9.67 d
28	9.50 d	61.39 b-e	4.55 a-c	5.15 d	2.49 c-f	8.37 ef	11.00 d	59.77 f	3.32 cd	5.29 d	2.66 d-f	8.61 e
32	11.00 c	55.20 c-e	4.65 a-c	4.59 de	2.16 d-f	7.38 f	12.47 c	56.50 f	3.40 cd	4.72 de	2.31 e-g	7.58 f
36	12.27 a	52.91 c-e	4.85 ab	4.03 ef	1.88 d-f	6.30 g	13.77 a	55.36 f	3.53 bc	4.16 ef	2.04 f-h	6.51 g
40	12.17 a	49.73 c-e	5.05 a	3.79 ef	1.43 ef	6.07 g	13.70 a	50.51 g	4.32 a	3.97 f	1.65 gh	6.36 g
44	11.97 ab	47.17 c-e	3.94 d	3.82 ef	1.51 ef	5.78 gh	13.47 ab	48.51 g	4.08 ab	3.93 f	1.64 gh	5.96 gh
48	11.50 bc	46.45 de	3.33 e	3.60 f	1.47 ef	4.86 hi	13.00 bc	45.95 g	3.30 c-e	3.71 f	1.61 gh	5.03 hi
52	7.83 f	39.48 e	2.80 ef	2.31 g	1.39 f	4.17 i	9.33 f	39.05 h	2.44 g	2.41 g	1.53 h	4.34 i

Values are the means of 3 replicates each with 7 pods. Values followed by the same letter within a column are not significantly different at the 0.05% level of probability according LSD test.

H*= Harvesting

Table (3):Content of dry weight, fiber,sugars (total, reducing and non-reducing) and total phenolic in pod at different maturity stages during 2009-2010 and 2010-2011seasons.

H*. Date (days)	2009-2010						2010-2011					
	Dry weight %	Fiber %	Sugars (mg/g FW)			Phenols (mg/100 g FW)	Dry weight %	Fiber %	Sugars (mg/g FW)			Phenols (mg/100 g FW)
			Red.	Non- red.	Total				Red.	Non- red.	Total	
8	9.22 e	4.02 g	6.15 g	10.61 g	17.31 g	60.77 a	8.56 d-f	4.31 g	6.37 i	9.38 g	16.24 i	55.37 a
12	9.54 c-e	6.41 f	15.09 f	12.64 fg	28.39 f	34.32 b	8.04 f	6.58 f	15.30 h	11.91 fg	27.84 h	30.42 b
16	9.26 e	7.64 e	17.43 f	13.27 fg	31.40 f	28.27 bc	8.41 ef	7.87 e	20.73 fg	14.69 f	36.19 g	27.65 bc
20	9.42 de	7.81 e	25.17 e	15.72 f	41.71 e	26.32 cd	9.03 c-e	8.28 e	25.62 ef	28.94 e	56.08 f	25.26 cd
24	9.73 c-e	9.51 d	30.93 d	30.04 e	62.54 d	20.68 de	9.19 c-e	9.95 d	30.92 cd	39.55 cd	72.54 de	20.42 ef
28	10.07 b-e	10.82 c	35.56 c	29.68 e	66.80 cd	19.52 de	9.40 b-d	11.19 c	35.18 bc	44.40 b	81.91 bc	16.46 g
32	10.38 a-e	11.89 b	39.75 b	36.98 d	78.68 b	17.39 e	9.61 bc	12.18 bc	40.31 ab	43.38 b	85.98 ab	16.41 g
36	10.65 a-d	11.87 b	46.68 a	42.04 c	90.93 a	17.14 e	9.82 bc	12.27 b	44.99 a	42.47 bc	89.70 a	16.82 g
40	10.76 a-c	12.04 b	37.87 bc	48.44 a	88.86 a	17.90 e	9.78 bc	12.51 b	44.80 a	42.61 bc	89.65 a	18.21 fg
44	11.25 ab	12.50 b	29.05 d	46.66 ab	78.17 b	18.19 e	10.22 b	12.42 b	36.88 b	39.65 cd	78.62 cd	18.56 fg
48	11.62 a	12.37 b	22.54 e	44.56 bc	69.43 c	20.49 de	11.53 a	13.07 b	29.42 de	39.00 d	70.47 e	18.66 fg
52	11.63 a	13.58 a	14.76 f	49.46 a	66.83 cd	22.29 c-e	11.90 a	14.24 a	17.50 gh	47.74 a	67.75 e	23.10 de

Values are the means of 3 replicates each with 7 pods. Values followed by the same letter within a column are not significantly different at the 0.05% level of probability according to LSD test.
H*= Harvesting