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# CHANGES IN PHYSICAL AND CHEMICAL PROPERTIES AND DETERMINATION OF HARVEST TIME OF SNOW PEAS AS AFFECTED BY POD DEVELOPMENT

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## 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 ofmaturity stage on the nutritional quality and determination of the best maturity stage of snow peassuitable for harvesting. The obtained results showed that the best maturity stage is at 20 days after flowering. Fresh weight, length and width of pods were increased and then decreased. Dry matter and crude fiber were increased while chlorophyll and vitamin C were decreased during pod development. Sugar content and SSC were increased and then decreased with maturation of pod. The highest content valuewere recorded at the $8^{th}$ day then decreased until the $28^{th}$ day, after these times, total phenolic content and increased until the $52^{nd}$ day.

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

## INTRODUCTION

The snow pea (*Pisum sativum*L. var. *macrocarpon*) is a distinct botanical cultivar or subspecies of *Pisum sativum* L. The pod is slab sided and is eaten before the string develops and the peas (seeds) start to swell. The snow pea is known by this name in Australia and the USA, but in England and France, it is called ‘mange-tout’, which means ‘eat-all’.The snow pea has a flat pod with minimal development of the seeds (Hocking, 1997; Suslow and Cantwell, 1998). Snow pea should be harvested when the pods are at maximum size but before any visible seed development; frequent harvesting is necessary (Hocking, 1997). Snow peas differ from the traditional garden peas, as ithas 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 sowing for export as a vegetables, as well as, it plays an important role for human nutrition as a cheap source of protein, carbohydrates, vitamins, minerals and other nutrients.The demand for snow pea pods has been increasing steadily in some markets such as the United State of America and Japan (Pariasca *et. al*., 2001).To retain the best quality, edible-podded peas are harvested before physiological maturity is reached.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 snow 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.No information is available in the literature about the change in nutritional quality during the growth cycle and proper harvest stage of snow 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 snow peas suitable for harvest.

## 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 ofmaturity stage on the nutritional quality and determination of the best maturity stage of snow peas (*Pisum sativum* L. var. *macrocarpon*)*cv*. 'Snow wind' suitable for harvesting.Seeds were sown on October 11, 2009 and on October 2, 2010 for the two seasons, respectively. Seeds of snow 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 colored 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 took place 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, spectrophotometricaly, 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 rafractometer 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 percent fresh weight percentage.

**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 Co-Hort 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, increased continually until 44 DAF and then it was gradually decrease. 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.

With regard to length of pods, rapid increase from 8 to 12 DAF was noticed then a gradual increase from 16 to 36 DAF occurred, in both seasons, whereas the highest length was detected after 36 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 snow peas ranged from 7.6 to 9 cm in length and1.9 cm in width (Hocking 1997). Width of pods quickly was increased from 8 to 12 DAF.Width increased until 24 DAF in the first season and until 28 DAF, in the second season then decreased, however no significant differences were

found between 24 DAF and 28 DAF, in both seasons. 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 pods 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 | 0.61 g | 4.10 e | 1.03 g | 0.48 f | 3.63 f | 0.90 f |
| 12 | 1.97 f | 7.17 d | 1.63 f | 1.36 f | 6.00 e | 1.43 e |
| 16 | 2.95 ef | 8.33 c | 1.87 e | 2.95 e | 8.30 d | 1.97 d |
| 20 | 3.76 e | 8.47 c | 1.97 d | 4.15 de | 8.87 cd | 2.10 cd |
| 24 | 5.64 d | 9.43 b | 2.43 a | 5.20 d | 9.33 bc | 2.27 ab |
| 28 | 7.51 c | 9.73 ab | 2.40 ab | 6.84 c | 9.60 a-c | 2.30 a |
| 32 | 8.02 bc | 9.97 ab | 2.30 c | 7.46 bc | 9.77 ab | 2.20 a-c |
| 36 | 8.54 a-c | 10.33 a | 2.27 c | 8.01 a-c | 10.20 a | 2.17 a-c |
| 40 | 9.62 a | 10.03 ab | 2.33 bc | 8.94 a | 9.83 ab | 2.23 a-c |
| 44 | 9.67 a | 10.10 ab | 2.30 c | 9.09 a | 9.90 ab | 2.20 a-c |
| 48 | 8.74 ab | 10.07 ab | 2.33 bc | 8.21 ab | 9.70 ab | 2.17 a-c |
| 52 | 8.09 bc | 9.63 b | 2.27 c | 7.49 bc | 9.40 bc | 2.13 bc |

**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, chlorophyll a, b and carotenoids in pod at different maturity stages. Soluble solids contents were increased gradually until 40 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 were 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 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) onsouthern peas found that vitamin C content was decreased with maturity on a dry weight basis from 135 mg per 100g on the $10^{th}$ day after flowering to 15 mg per 100g on the $20^{th}$ 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 show in table (2) acidity was reduced during pod development, 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 was declined continuously during pod development stages with a sharp reduction from 8 to 16 DAF, and then a gradual decrease was noticed. There were significant differences in chlorophyll a and carotenoids from 20 to 24$^{th}$ day in both seasons. 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 decreases 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 porfirinic nucleus decomposes liberating magnesium (Fleancu, 2007).

Dry matter and fiber content in pods 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 was continuously increased during maturity stages. This trend is similar to that reported before by Bisson and Jones (1932) on peasand Hoover (1952) on green beans. The fiber content of the side wall is the most important constituent which influences the edible quality of snow peas. Fiber in pod was increased rapidly from 8 to 24 DAF and increased slowly thereafter until 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 snow peas at the 20$^{th}$ day is the best maturity stages which have low fiber content, based on the condition of our experiment.

The results given in table (3) present the content of sugars (total, reducing and non-reducing) and total phenolic in pod at different maturity stages. Total and reducing sugars were increased until 32 and 28 DAF in the first and second seasons, respectively, then declined again. While, non-reducing sugars were elevated until 48 and 40 DAF in the first and second seasons, respectively, then reduced. 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 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).

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As shown in table (3), the highest phenolic content value was at the 8th day in both seasons, and then decreased up to the 28th day in both seasons. After that, total phenolic content was again increased slightly until the 52nd day in both season. 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 attribute 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 snow peas is 20 days after flowering because at that time the pods have high quality features such as low crude fiber, dry weight percentage. At this time pods chemical parameters are proper for consumers, in addition SSC, vitamin C, sugars and phenolic are still high.

## REFERENCES

A.O.A.C. (1996). Official methods of analysis, association of official analytical chemists, Washington DC.

Amiot, M.J., M. Tacchini, S.Y. Aubert and W. Oleszek (1995). Influence of cultivar, maturity stage, and storage conditions on phenolic composition and enzymatic browning of pear fruits. Journal of Agricultural and Food Chemistry 43(5): 1132–1137.

Bisson, C.S. and H.A. Jones (1932). Changes accompanying fruit development in the garden pea. Plant Physiology 7: 91-106.

Dubois, M.K.A., J.K. Hamilton, P.A. Rebers and F. Smith (1956). Colorimetric method for determination of sugars and related substances, Anal. Chem. 28: 350-356.

Fawole, O.A. and U.L. Opara (2013). Effects of maturity status on biochemical content, polyphenol composition and antioxidant capacity of pomegranate fruit arils (cv. 'Bhagwa'). South African Journal of Botany 85: 23–31.

Fleancu, M. (2007). Correlations among some physiological processes in apple fruit during growing and maturation processes. International Journal of Agriculture and Biology 9 (4):613 - 616.

Hocking, D.F. (1997). Snow peas and sugar snap peas. Agfact H8.1.35, NSW Agric., Sydney, Australia.

Hoover, M.W. (1952). The importance of stage of maturity upon the edible quality of green beans, lima beans and southern peas. FloridaState Horticultural Society Vol. LXV: 133-137.

Ishak, S.A., N. Ismail, M.A.M. Noor and H. Ahmad (2005). Some physical and chemical properties of ambarella (*Spondias cytherea* Sonn.) at three different stages of maturity. Journal of Food Composition and Analysis 18: 819–827.

Lee, C.Y., L.M. Jr. Massey and J.P. Van Buren (1982). Effects of postharvest handling and processing on vitamin contents of peas. Journal of food science 47: 961-964.

Lichenthaler, H.K. and W.R. Wellburn (1983). Determination of total carotenoids and chlorophylls a and b of leaf extracts in different solvents. Biochem. Soc. Trans. 11: 591–592.

Maynard, A.J. (Ed.) (1970). Methods in Food Analysis, Academic Press, New York, p. 176.

Mazumdar, B.C. and K. Majumder (2003). Methods on physico-chemical analysis of fruits. Daya Publishing House, Delhi-110035, pp.162-163.

Moneruzzaman, K.M., A.B.M.S. Hossain, W. Sani and M. Saifuddin (2008).Effect of stages of maturity and ripening conditions on the biochemical characteristics of tomato. American Journal of Biochemistry and Biotechnology 4 (4): 336-344.

Montero, T.M., E.M. Molla, R.M. Esteban and F.J. Lopez-Andreu (1996). Quality attributes of strawberry during ripening. Scientia Horticulturae 65: 239-250.

Moore, T.C. (1974). Research experiences in plant physiology. A laboratory Manual. Springer-Verlage, Berlin, Heidelberg, p. 3-12.

Nagy, S. (1980). Vitamin C contents of citrus fruit and their products: a review. J. Agric. Food Chem. 28: 8-18.

Ornelas-Paz, J. De J., E.M. Yahia, N. Ramirez-Bustamante, J.D. Perez-Martinez, M.D.P. Escalante-Minakata, V. Ibarra-Junquera, C. Acosta-Muniz, V. Guerrero-Prieto and E. Ochoa-Reyes (2013). Physical attributes and chemical composition of organic strawberry fruit (*Fragaria x ananassa Duch*, Cv. Albion) at six stages of ripening. Food Chemistry 138: 372-381.

Pariasca, J. A.T., T. Miyazaki, H. Hisaka, H. Nakagawa and T. Sato (2001). Effect of modified atmosphere packaging (MAP) and controlled atmosphere (CA) storage on the quality of snow pea pods (*Pisum sativum* L. var. saccharatum). Postharvest Biology and Technology. 21: 213-223.

Pearson, D. (1970). The chemical analysis of foods (6th ed.), T.A Constable, London.

Sturm, K., D. Koron and F. Stampar (2003). The composition of fruit of different strawberry varieties depending on maturity stage. Food Chemistry 83: 417-422.

Suslow, T.V. and M. Cantwell (1998). Peas-Snow and Snap Pod Peas. Perishables Handling Quarterly, Univ. of Calif., DavisCA, 93:15-16.

Tosun, I., N.S. Ustun and B. Tekguler (2008). Physical and chemical changes during ripening of blackberry fruits. Sci. Agric. 65(1): 87-90.

Vendramini, A.L. and L.C. Trugo (2000). Chemical composition of acerola fruit (*Malpighia punicifolia* L.) at three stages of maturity. Food Chemistry 71: 195-198.

Watadal, A.E. and L.L. Morris (1967). Growth and respiration patterns of snap bean fruits. Plant Physiology 42: 757-761.

## التغيرات فى الخصائص الفيزيائية والكيميائية وتحديد موعد الحصاد للبسلة الجلدية وتأثرها بتطور نمو القرن

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**** قسم بحوث تداول محاصيل الخضر ـ معهد بحوث البساتين ـ مركز البحوث الزراعية ـ الجيزة ـ مصر.**

تم إجراء هذه التجربة فى مزرعة كلية الزراعة جامعة قناة السويس بالإسماعيلية خلال موسمى الزراعة ٢٠٠٩-٢٠١٠م و ٢٠١٠-٢٠١١م و ذلك لدراسة تأثيرمراحل النضج المختلفة لقرون البسلة الجلدية صنف سنو وند على تطور النمو و المحتوى الكيماوى للقرون و كذلك تحديد أفضل مرحلة نضج مناسبة للحصاد. وقد اتضح من النتائج أن أفضل مرحلة للحصاد عندما تكون القرون فى عمر ٢٠ يوماً بعد الإزهار.زاد كل من وزن و طول و عرض القرن مع تقدمه فى العمر ثم انخفض فى المراحل المتأخرة من نضجه. زاد كل من المادة الجافة و محتوى الألياف بينما انخفض كل من محتوى الكلورفيل و حامض الأسكوربك، فى حين أن محتوى السكريات و المواد الصلبة قد زاد ثم انخفض مع نمو القرن و تطوره فى العمر. كان أعلى محتوى للفينولات فى بداية عمر القرن ثم انخفضت تدريجياً حتى اليوم ٢٨ ثم زادت بعد ذلك.

**قام بتحكيم البحث**

**أ.د / سمير طه العفيفى — كلية الزراعة – جامعة المنصورة**

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

| 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** | 6.33 f | 133.28 a | 3.95 ab | 22.25 a | 13.43 a | 34.09 a | 8.33 e | 188.11 a | 4.42 ab | 27.92 a | 16.72 a | 42.64 a |
| **12** | 6.33 f | 99.16 b | 3.99 ab | 14.62 b | 8.15 b | 33.91 a | 7.67 f | 139.62 b | 4.33 ab | 16.40 b | 9.11 b | 37.75 b |
| **16** | 7.33 e | 83.59 c | 3.53 bc | 14.32 b | 7.20 c | 27.98 b | 7.67 f | 95.44 c | 4.43 ab | 15.50 c | 7.79 c | 30.20 c |
| **20** | 8.00 e | 65.24 d | 3.93 ab | 12.95 c | 5.73 d | 21.53 c | 9.63 d | 85.14 c | 4.50 a | 14.09 d | 6.25 d | 23.45 d |
| **24** | 9.30 d | 50.94 e | 4.36 a | 11.75 d | 5.12 de | 17.21 d | 10.07 d | 64.85 d | 3.81 bc | 13.02 e | 5.69 de | 19.17 e |
| **28** | 10.23 c | 45.86 f | 3.44 b-d | 10.22 e | 4.86 e | 15.12 e | 10.93 c | 46.56 e | 3.53 cd | 11.15 f | 5.31 d-f | 16.58 f |
| **32** | 11.17 b | 41.02 fg | 3.22 c-e | 8.80 f | 4.71 ef | 12.88 f | 12.00 b | 44.32 e | 3.35 c-e | 9.64 g | 5.14 ef | 14.19 g |
| **36** | 11.93 ab | 37.57 gh | 3.04 c-e | 6.92 g | 3.99 f | 10.62 g | 12.67 a | 41.62 ef | 3.29 c-e | 7.66 h | 4.39 fg | 11.83 h |
| **40** | 12.27 a | 34.90 hi | 3.10 c-e | 5.88 h | 3.13 g | 8.84 h | 13.00 a | 36.85 e-g | 3.22 c-e | 6.50 i | 3.44 gh | 9.83 i |
| **44** | 12.17 a | 31.55 ij | 2.84 de | 5.69 hi | 3.09 g | 8.31 h | 12.87 a | 32.11 fg | 2.91 de | 6.25 ij | 3.37 h | 9.20 i |
| **48** | 11.83 ab | 29.98 ij | 2.69 e | 5.04 ij | 3.05 g | 7.92 h | 12.63 a | 30.69 g | 2.77 e | 5.55 jk | 3.32 h | 8.76 i |
| **52** | …… | 27.10 j | 2.62 e | 4.63 j | 2.76 g | 8.04 h | …… | 28.77 g | 2.72 e | 4.92 k | 2.91 h | 8.53 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 to 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** | 9.95 ef | 5.90 g | 7.20 j | 10.38 e | 18.12 i | 60.63 a | 9.38 e | 5.64 h | 6.59 j | 10.58 f | 17.73 h | 59.06 a |
| **12** | 9.78 ef | 7.95 f | 10.69 i | 10.66 e | 21.91 h | 42.96 b | 10.05 e | 7.79 g | 9.64 i | 10.85 f | 21.06 g | 44.31 b |
| **16** | 8.35 f | 9.17 e | 15.32 h | 11.16 e | 27.07 g | 33.04 c | 9.74 e | 9.26 f | 13.79 h | 11.32 f | 25.71 f | 33.60 c |
| **20** | 10.15 ef | 10.07 d | 19.93 g | 12.09 e | 32.65 f | 27.50 de | 10.35 e | 10.11 e | 18.55 g | 10.79 f | 29.90 e | 28.60 de |
| **24** | 10.62 d-f | 12.86 c | 27.42 d | 17.86 d | 46.22 e | 24.88 f | 10.66 de | 12.72 d | 27.67 d | 16.34 e | 44.87 d | 25.77 d-f |
| **28** | 10.60 d-f | 13.20 bc | 34.76 ab | 21.26 c | 57.14 ab | 22.76 g | 10.67 de | 13.08 cd | 36.51 a | 20.71 d | 58.31 a | 23.49 f |
| **32** | 11.62 de | 13.68 b | 35.88 a | 22.18 bc | 59.23 a | 23.82 fg | 11.86 de | 13.57 bc | 33.47 b | 22.30 cd | 56.94 ab | 24.52 f |
| **36** | 12.74 d | 13.25 bc | 34.10 b | 20.16 c | 55.32 bc | 24.60 fg | 13.12 cd | 13.62 bc | 30.52 c | 23.84 a-c | 55.61 b | 25.32 ef |
| **40** | 12.81 cd | 13.75 b | 30.19 c | 24.02 ab | 55.47 bc | 25.07 f | 13.07 cd | 13.51 bc | 27.49 d | 26.77 a | 55.67 b | 25.84 d-f |
| **44** | 15.20 bc | 13.91 b | 28.24 d | 23.95 ab | 53.45 cd | 25.73 ef | 15.64 bc | 13.80 bc | 25.10 de | 26.34 ab | 52.82 c | 26.53 d-f |
| **48** | 17.45 b | 13.59 bc | 25.36 e | 25.39 a | 52.09 d | 29.38 d | 18.15 b | 14.05 b | 22.55 ef | 26.27 ab | 50.20 c | 29.24 d |
| **52** | 22.82 a | 15.19 a | 21.84 f | 25.05 a | 48.20 e | 34.37 c | 24.65 a | 15.21 a | 21.49 f | 23.45 b-d | 46.17 d | 36.34 c |

**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**