JKAU: Sci., **Vol. 21** No. 2, pp: 317-326 (2009 A.D. / 1430 A.H.); DOI: 10.4197 / Sci. 21-2.9

Evaluation of Objective Maturity Indices for Muskmelon (Cucumis melo) *cv*."Galia"

Omer Khidir Ahmed

Dept. of Biology, Teachers College, Taif
P.O. Box 1070, Kingdom of Saudi Arabia

Abstract. Muskmelon (*Cucumis melo*) *cv*. "Galia" was studied to determine optimum harvest maturity index for export from Sudan, as importers require persistent stem-end attachment to the fruits. Ground colour of harvested melons was related to stem-end attachment. A sample of 4 fruits each at different maturity stages of all green, 25%, 50%, 75%, and 100% brown were selected.

Maturity was evaluated based on slipping, force needed to detach slip from the melon, distance between net strands, net toughness, cavity size and edible length and soluble solids concentrations (SSC).

The 50% colour intensity was found to be an appropriate maturity index. At this colour, the melons were at the half-slip stage with persistent stem-end, which is acceptable to importers. The melons had high externals qualities of netting, net toughness, and cavity and edible size and best internal quality in terms of SSC.

Fruits harvested post the 50% colour reached advanced stages of maturity and had poor stem-end attachment, thereby not meeting importers requirements. These fruits had excellent qualities but were only suitable for local markets.

Keywords: *Muskmelon (Cucumis melo) "Galia", maturity index, slipping.*

Introduction

The muskmelon (*Cucumis melo*) is a popular crop in Sudan and is used mainly as a desert and refreshing fruit. According to a study by the Ministry of National Planning, Sudan[1] the muskmelon ranked tenth in acreage among the 20 principle vegetables grown, but ranked fourth in

value among vegetables exported. The potentiality of muskmelon for export stems from the fact that it is a relatively hard fruit with a keeping quality of over two weeks in netted cultivars[2,3]. Soilless production of Galia muskmelon under greenhouse conditions for export is reported feasible in Florida[4].

Recently, the Arab Company for Agricultural Production and Processing (Sudan) Ltd. (ACAPP) has tried a large scale of out-of-season export of the cultivar Galia, a netted F1 hybrid muskmelon[5,6] to the Netherlands. Infact, this cultivar is very popular in Europe[7]. However, the ACAPP had experienced some problems as importing and distributing agents in Holland, required that the stem-end be attached to the melon fruits. These problems had resulted in price reduction and/or rejection of whole consignments.

The ACAPP would only be able to export large quantities of muskmelons to the Netherlands by accepting the maturity indices required by Dutch agents. Yet, when melons were harvested with attached stem-end, as demanded, the fruits were either relatively immature[8] or unripe[9].

Harvest maturity studies on melons in Sudan are lacking. Slipping is a proper criterion of maturity index in muskmelon[8] but is difficult to ascertain and requires well trained labours. As a maturity index, ground colour has the advantage of being nondestructive[10] and easy to determine[11]. Ground colour has been used as an indication of maturity in harvesting several fruits including bananas[12,13], peach[14], watermelon[15], and guava[16,17].

In the present study muskmelon fruits were harvested at different stages of skin ground colour to determine optimum harvest maturity. The main objectives being to relate background colour of harvested melons to attached stem-end and acceptable physical and internal qualities.

Materials and Methods

Fruit Source

Muskmelon (Cucumis melo, *cv.* Galia) fruits were obtained from the ACAPP farm at Um Doom 25 km North of Khartoum. The melon seeds were imported from the Royal Sluis Seed Company, the Netherlands, and grown for out-of-season export during the winter. Three harvests were

made on the eighth, thirteenth and seventeenth of January. The period between sowing and harvesting was 80-120 days. The experiment was repeated for two seasons.

Sample Preparation

Samples of four fruits each at different maturity stages of all green and 25%, 50%, 75%, and 100% brown were selected. The fruits were harvested with sharp knives in such a way to allow the attachment of the stem-end with the fruits. Melons were then carefully packed in baskets and transported by truck to the laboratory of the Department of Horticulture, Shambat, University of Khartoum, and left at room temperature until the next morning.

Harvest Maturity Indices

Melons maturity was determined on the angularity of ridges on the stem-end. A cross section was made on the stem-end of the melon with a knife and then rated on the angularity of ridges as "full-", "half-"and "quarter-slip". In the "full-slip" stage, the ridges had completely disappeared from the stem-end and the fruit reached advanced maturity. In the "half-slip", the ridges had disappeared halfway from the stem-end and the fruit was less mature, whereas in the "quarter-slip", the ridges were prominent on the stem-end and the fruit was immature.

Maturity was also assessed by hand pulling the attached stem-end from the melon fruit and the ease of removal rated from 1 to 3, where: 1= easy to pull; 2 = medium; 3 = difficult to pull.

Netting was estimated by measuring area between net strands where smaller area indicated a densely netted melon. Net toughness was determined by scuffing across nets with a sharp knife and rated from 1 to 3, where: 1 = net easily scuffed; 2 = medium; 3 = resistant.

Evaluation of Physical Characteristics

Fruit length and circumference were measured by a tape metre and the ratio of fruit length/circumference calculated. Cavity size and edible length were also measured by a tape metre after making a transverse cut across the melon fruit.

Soluble Solids Concentration

Soluble solids concentration (SSC) was measured at three different regions of the mesocarp of the melon fruit (Fig. 1). Samples were taken from near cavity, middle of the pulp and near skin, and the SSC read by an Abbee refractometer.

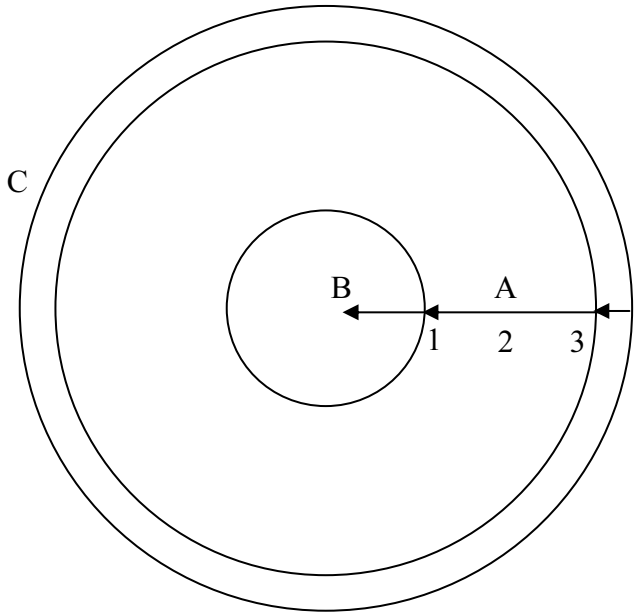

Fig. 1. Sampling regions used in assessing soluble solids concentration within muskmelon fruits, where:
(A) Pulp, (B) cavity and (C) skin regions.
(1) Near cavity, (2) middle of pulp and (3) near skin.

Results and Discussion

Muskmelon reached advanced maturity with increase in skin intensity (Table 1). Thus, when background colour was 75% brown or more the fruits reached "full-slip" maturity and the stem-end was round with virtually no ridges. At this stage, the fruits were at a very advanced maturity thereby not suitable for distant shipment. However, they were best for local markets. At 25% or 50% brown colour, the melons were at the "half-slip" stage with a rather angular stem-end (Table 1). At this stage, the fruits were less mature and were appropriate for long distant

markets. However, all green fruits only reached the "quarter-slip" stage with prominent ridges on the stem-end and were immature.

The force needed to separate the melon from its attached stem-end, also, decreased with increase in background colour (Table 1). Thus at the full brown colour the stem-end separated very easily from the melon. At 50% and 75% brown colour intensity stem-end separation was intermediate but, however, difficult at the green and 25% brown stages. Therefore, 50% brown colour appeared to be a suitable maturity index for harvesting melons for export. Fruits at this stage had reached the "half-slip" stage, requiring more pressure to detach from their stem-end, as compared to fruits at the 75% brown colour, which had reached the "full-slip" stage.

Table 1. Effect of ground colour as a maturity index on slipping, pulling, netting and net toughness of muskmelon fruit.

Ground colour	Slipping[1]	Pulling[2]	Netting[3] (cm)	Net[4] toughness
Green	quarter-slip	3	0.40	3
25% brown	half-slip	3	0.44	3
50% brown	half-slip	2	0.45	2
75% brown	half-slip	2	0.47	2
100% brown	half-slip	1	0.48	1

1. Ridges disappeared completely from stem-end = full slip.
   Ridges disappeared half-way from stem-end = half-slip.
   Ridges prominent on stem-end = quarter-slip.
2. Easy to pull = 1; medium = 2; difficult = 3.
3. Diameter of area between net strands.
4. Net easily scuffed = 1; medium = 2; resistant = 3.

Similarly Nunez *et at.*[9], indicated that melons shipped to distant markets are harvested at the "half-slip" stage. Further, fruits harvested at the 50% brown colour would avoid pathogenic contamination in the stem cavity left as a result of stem-end removal at harvest.

Netting slightly increased with increase in background colour (Table 1). In comparisons of netted and non-netted muskmelon cultivars[3] and Vazquez-Ocho[8,16] indicated that netting shortened the post harvest shelf life in netted melon. This was attributed to high transpiration through the open netted rind[3] or through production of high ethylene at or near harvest in netted cultivars[9,18,19] as compared to 20 days post harvest in non-netted fruits[18]. Since Galia muskmelon is a medium netted cultivar[5,6] net development can be seen as a maturity sign. At the 50%

brown colour stage values for netting density were intermediate in comparison with values for other stages (Table 1). This would favour the 50% brown stage as an appropriate harvest maturity index for export purposes of Galia melons.

However, net resistance to scuffing was weakened with skin colour development, such that at full brown colour, net was easily scuffed as compared to fruits at the green or 25% brown stages (Table 1). This would indicate that the epidermal tissue can also be seen as a maturity index in harvesting Galia melon fruits and that net toughness is important for protection of melon skin during shipping[20]. However, values of net toughness were in the medium range in both the 50% and 75% brown coloured stages.

Fruit length, circumference, cavity size and edible length decreased slightly with increase in background colour of the fruits at harvest (Table 2). Fruit length to circumference ratios were close to unity at all stages which indicated round fruits, a quality preferred in grading and packing fruits for shipping. The small cavity size seen with advancement in ground colour intensity is an advantage quality parameter of Galia melons[8] and (Table 2). However, edible portion decreased with ground colour development. At 50% brown colour stage, fruits showed medium values for both cavity size and edible portion, which are highly preferred quality standards in melons.

Table 2. Effect of ground colour as a maturity index on five physical characteristics of muskmelon fruit.

Ground colour	Fruit physical characteristics (cm)[1]				
	Length	Circumference	Length/circum. Ratio	Cavity size	Edible length
Green	37 ± 0.2	37.6 ± 0.2	0.98 ± 0.01	5.85 ± 0.1	3.60 ± 0.01
25% brown	36 ± 0.2	37.1 ± 0.1	0.97 ± 0.01	5.50 ± 0.2	3.50 ± 0.01
50% brown	35.4 ± 0.1	36.5 ± 0.1	0.97 ± 0.01	5.30 ± 0.2	3.30 ± 0.01
75% brown	35.2 ± 0.1	36.4 ± 0.1	0.97 ± 0.01	5.20 ± 0.2	3.15 ± 0.02
100% brown	35.1 ± 0.1	35.9 ± 0.2	0.98 ± 0.01	5.16 ± 0.2	3.08 ± 0.02

[1] Average of 4 readings
± = standard deviation

Galia melon fruits were sweet containing more than 11% SSC (Table 3). Similar values for soluble solids in the same muskmelon cultivar were

reported[4,5,6,8]. Fruits harvested at the 50% ground colour stage were even sweeter showing relatively greater SSC values in all regions of the flesh as compared with fruits harvested at the other stages of colour intensity (Table 3). Similarly Simandjuntak[21], reported a decrease in sugars during ripening in Cantaloupe and Honey Dew melons, and that sucrose was the predominant sugar in ripe fruits, while glucose and fructose were higher in immature fruits Villanueva[22]. The decrease in SSC with advancement in maturity, presented here, might be attributed to metabolism of sugars due to increased respiration with high temperature in the field since muskmelon is a climacteric fruit[10,23] and contains no starch reserves that could be converted to sugars[24]. In this regard, the use of superatmospheric O_2 atmospheres were proposed to reduce respiration and maintain firmness of fresh-cut melons[25].

Table 3. Effect of ground colour as a maturity index on soluble solids concentration measured at three regions of muskmelon fruit mesocarp.

Ground colour	Fruit physical characteristics (cm)[1]		
	Near cavity[2]	Middle region[2]	Near skin[2]
Green	14.40 ± 0.1	12.80 ± 0.2	11.08 ± 0.1
25% brown	14.80 ± 0.1	13.2 ± 0.1	11.80 ± 0.1
50% brown	14.60 ± 0.1	13.16 ± 0.2	11.80 ± 0.1
75% brown	14.58 ± 0.1	13.08 ± 0.1	11.40 ± 0.2
100% brown	14.50 ± 0.2	12.00 ± 0.2	11.25 ± 0.2

1 Average of 4 reading
2 See Fig. 1
± = standard deviation

At all maturity stages, the inner flesh of the melon has higher SSC with a gradual decrease towards the rind, and SSC was as much as 19% lower at the skin region than near cavity (value calculated for the 50% colour stage, see Table 3). A similar order of SSC between the heart and top or soil sides was reported in watermelons[26], and differential ripening between pulp and rind in Cantaloupe melon was proposed[20]. The inner region of the melon is the site of fertilized ovules, establishing the cavity as a relatively strong sink for starch early in fruit development, which is later converted to sugars. This would account for the high ranking of the cavity side in SSC at maturity shown in the present study.

References

[1] **Ministry of National Planning, Democratic Republic of the Sudan,** Project for out-of-season vegetable production-B-market studies report by *Scoiete Centrale Pour I 'Equipement du Territoire international* (*Scet International*), p. 112 (1980).

[2] **Lester, G.E.** and **Bruton, B.D.,** Relationship of netted muskmelon fruit water loss to post harvest storage life, *J. Amer. Soc. Hort. Sci.*, **111**(5): 727-731 (1986).

[3] **Lester, G.E.,** Comparisons of 'Honey Dew' and netted muskmelon fruit tissues in relations to storage life, *Hort. Science*, **23**(1): 180-182 (1988).

[4] **Shaw, N.L., Cantliffe, D.J., Rodriquez, J.C.** and **Shine, C.,** Economic feasibility of producing Galia muskmelons in passive ventilated greenhouse and soilless culture in North Central Florida, *Proc. Fla. State Hort. Soc.*, **117:** 38-42 (2004).

[5] **Karchi, Z.** and **Govers, A.,** The Galia melon, a new F1 hybrid for export and the local market, *Hassadeh,* **57**(4): 630-634 (1977).

[6] **Schultheis, J.R., Jester W.R.** and **Augostini N.J.,** Screening melons for adaptability in North Carolina. pp: 439-444. In: J. Janick and A. Whipkey (eds.), *Trends in New Crops and New Uses,* ASHS Press, Alexandria, VA (2002).

[7] **Jett, L.W.,** Galia muskmelon: A potentially profitable early-season crop for high tunnels in the Central Great Plains, *HortScience*, **41**(3): 215-221. (2006).

[8] **Artes, F., Escriche, A.J., Martinez, J.A.** and **Marin, J.G.,** Quality factors in four varieties of melon (*Cucumis melo,* L.), *Journal of Food Quality*, **16**(2): 91-100 (1993).

[9] **Nunez-Palenius, H.G., Huber, D.J., Klee, H.J.** and **Cantliffe, D.J.,** Fruit ripening characteristics in a transgenic "Galia" male parental muskmelon (*Cucumis melo,* L. var. *reticulates* Ser.) line, *Postharvest Biology and Technology*, **44**(2): 95-100 (2007).

[10] **Almela, L., Sanchez, C., Fernandez-Lopez, J.A.** and **Romojaro, F.,** Note: Non-destructive appraisal of ripeness in Cantaloupe melons, *Food Science and Technology International*, **6**(1): 47-51 (2000).

[11] **Asghary, M., Babalar, M., Talaei, A.** and **Kashi, A.,** The influence of harvest maturity and storage temperature on quality and Postharvest life of "Semsory" muskmelon fruit. ISHS Acta Horticulturae, **682: V.,** *International Postharvest Symposium* (2004).

[12] **Ahmed, O.K.** and **Tingwa, P.O.,** Effect of gibberellic acid on several parameters of ripening banana fruits (*Musa* sp. cv. Dwarf Cavendish), *University of Khartoum Journal of Agricultural Sciences*, **3**(1): 47-49 (1995).

[13] **Ahmed, O.K.,** Effect of ethrel on banana fruit ripening, *University of Khartoum Journal of Agricultural Sciences,* **5**(1): 80-92 (1997).

[14] **Delwiche, M.J.** and **Baumgardner, R.A.** (1985) Ground colour as a peach maturity index, *J. Amer. Soc. Hort. Sci.*, **110**(1): 53-57.

[15] **Coney, K.A.** and **Schlimme, D.V.,** Relationship of rind gloss and ground spot colour to flesh quality of watermelon fruits during maturation, *Scientia Horticulturae*, **32**(3/4): 211-218 (1988).

[16] **Vazquez-Ochoa, R.I.** and **Colinas-Leon, M.T.,** Changes in guavas of three maturity stages in response to temperature and relative humidity, *HortScience*, **25**(1): 86-87 (1990).

[17] **El-Buluk, R.E., Babikar, E.E.** and **El Tinay, A.H.,** Biochemical and physical changes in fruits of four guava cultivars during growth and development, *Food Chemistry*, **54**(3): 279-282 (1995).

[18] **Kendall, S.A.** and **Ng, T.J.,** Genetic variation of ethylene production in harvested muskmelon fruits, *HortScience*, **23**(4): 769-761 (1988).

[19] **Dunlap, J.R., Lingle, S.E.** and **Lester, G.E.,** Ethylene production in netted muskmelon subjected to post-harvest heating and refrigerated storage, *HortScience*, **25**(2): 207-209 (1990).

[20] **Flores, F.B., Martinez-Madrid, M.C., Sanchez-Hidalgo, F.J.** and **Romojaro, F.,** Differential rind and pulp ripening of transgenic antisenseACC oxidase melon, *Plant Physiology and Biochemistry*, **39**(1): 37-43. (2001).

[21] **Simandjuntak, V., Barrett, D.M.** and **Wrolstad, R.E.,** Cultivar and maturity effects on muskmelon (*Cucumis melo*) colour, texture and cell wall polysaccharide composition, *Journal of the Science of Food and Agriculture*, **71**(3): 282-290 (1999).

[22] **Villanueva, M.J., Tenorio, M.D., Esteban, M.A.** and **Mendoza, M.C.,** Compositional changes during ripening of two cultivars of muskmelon fruits, *Food Chemistry*, **87**(2): 179-185 (2004).

[23] **Lyons, J.M., McGlasson, W.B.** and **Pratt, H.K.,** Ethylene production, respiration and internal gas concentrations in cantaloupe fruits at various stages of maturity, *Plant Physiology*, **37**: 31-36**.** (1962).

[24] **Cohen, R.A.** and **Hicks, J.R.,** Effect of storage on quality and sugars in muskmelon, *J. Amer. Soc. Hort. Sci.*, **111**(4): 553-559 (1986).

[25] **Oms-Oliu, G., Soliva-Fortuny, R.** and **Martin-Belloso, O.,** Modeling changes of headspace gas concentrations to describe the respiration of fresh-cut melon under low or superatmospheric oxygen atmospheres, *Journal of Food Engineering*, **85**(3): 401-409 (2008).

[26] **Chisholm, D.N.** and **Picha, D.H.,** Distribution of sugars and organic acids within ripe watermelon fruit, *HortScience*, **21**(3): 501-503 (1986).

التقييم المعنوي لأدلة اكتمال النمو في الشمام صنف قاليا

عمر خضر أحمد

قسم الأحياء، كلية المعلمين بالطائف

ص ب ١٠٧٠، الطائف، المملكة العربية السعودية

المستخلص. تمت دراسة الشمام صنف قاليا لتحديد اكتمال النمو الأمثل لقطف الثمار للتصدير من السودان ليلبي طلب الموردين في بقاء العنق متصلاً بالثمرة. وعليه فقد تم ربط علاقة بين بقاء العنق ولون الثمار. لقد تم اختيار عينات مكونة من ٤ ثمار عند درجات مختلفة من لون البشرة كالآتي: ثمار خضراء تماماً وثمار تلونت بشرتها باللون البني بنسبة ٢٥ و٥٠ و٧٥ و١٠٠٪.

وجد أن الثمار التي تلونت بشرتها بنسبة ٥٠٪ هي الأمثل لقطف الثمار من حيث بقاء العنق متصلاً بالثمار وهذا ما يطلبه المستوردون. هذه الثمار تميزت بدرجة عالية من الجودة الخارجية متمثلةً في كثافة الغطاء الشبكي على البشرة وقوته وصغر حجم التجويف مع كبر الجزء المأكول. إضافةً إلى أنها ذات جودة داخلية عالية بناءاً على تركيز المواد الصلبة الذائبة.

أما الثمار التي تخطي لون بشرتها نسبة ٥٠٪ فقد دخلت مراحل متقدمة من النضج وأصبح بقاء العنق عليها ضعيفاً، وهذا لا يلبي متطلبات المستوردين. هذه الثمار ذات جودة أكلية عالية لكنها تصلح للأسواق المحلية فقط.