Physical properties measurements of okra fruits using image processing to predict of visual maturity index

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Abstract: This work was intended to classify okra pods, according to their length and diameter by determining, the measure and image dimensions,to compare accuracy image measuring of dimensions, in order to quality attributes and to know harvest maturity index. Obtained results were included as follows:.

The relationship between the measure and image of the diameter of okra pods has a high correlation (R^2= 0.9117). Therefore, the standard grading according to image diameter as follows: The "very small" group includes okra pods less than 1.22 cm (<1.22 cm) in diameter; the "small"group includes okra pods not less than 1.22 cm or more than 1.77 cm (1.22 to 1.77 cm); the "medium" class includes okra pods more than 1.77 cm and not ore than 2.52 cm (1.77 to 2.52 cm) in diameter; and the "large" group includes okra pods more than 2.52 cm (> 2.52 cm).The relationship between the measure and image of the length of okra pods has a high correlation (R^2= 0.9783). Therefore, the standard grading according to image length as follows: The "very small" group includes okra pods less than 2.42 cm (<2.42 cm) in length; the "small"group includes okra pods not less than 2.42 cm or more than 4.08 cm (2.42 to 4.08 cm); the "medium" class includes okra pods more than 4.08 cm and not more than 6.10 cm (4.08 cm to 6.10 cm) in length; and the "large" group includes okra pods more than 6.10 (> 6.10 cm). The difference percentage between color values, which measuring by line and rectangle pixel methods. The minimum values were of 9.09%, 7.22% and 6.67%, and for maximum valueswere about 1.69%, 2.94%, and 6.67%, and for average values were 6.89%, 5.24% and 6.79% for Red (R) and Green (G) and Blue (B) values, respectively. Therefore, According to measure of color and size of okra fruits, the measurements considering visual means as a Maturity index of okra fruits.

Keywords: okra, harvesting index, dimensions, image analysis, physical properties

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1 Introduction

Okra originated in Ethiopia and was then propagated in North Africa, in the Mediterranean, in Arabia and India by the 12th century BC. Okra is known by many local names in different parts of the world. It is called lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhindiinIndia .

Okra, botanically, this perennial flowering plant belongs to the *mallow* family and named scientifically as *Abelmoschus esculentus***,** okra, also known as *"lady*

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finger" or "gumbo", is a highly nutritious green edible pod vegetable and an economically important vegetable crop grown in tropical and sub-tropical parts of the world. , with considerable diversity in size, shape, and colour of the edible pods. Plants range in height from 1 meter (3 ft) in dwarf cultivars to over 2.6 meters (8 ft) in tall cultivars. Okra plants can be cut back to 15 to 20 cm (6 to 8 in) above the ground to produce a second crop. Okra is a highly perishable vegetable with a limited market life.The plant bears numerous dark green colored pods measuring about 5-15 cm in length. It takes about 45-60 days to bear ready-to-harvest fruits.

El-Waraky (2014) mentioned that an okra plant cultivated in mid-April produced the highest mean values of vegetative growth in comparison with the other sowing dates.It was also noticed that, produced the highest mean values of seed yield and its components, i.e., seed yield per plant, seed yield per fed., number of pods plant, number of seed pod, seed yield per pod weight of 100-seeds, pod weight and seed germination percentage.

Mohamed et al. (2016) seed production and quality of okra were obviously influenced by sowing date, harvest date and pod position on the mother plant. Pods at lower or middle positions on the okra plant exhibited the best values in seed yield in terms of seed number/pod, seeds weight/ pod, 100 seed weight and quality in terms of germination percentage, root and shoot length of seedlings. All possible combinations had a significant effect on pod diameter, seed index, germination percentage and shoot in both seasons.

Daniela et al. (2012) studied some physical properties of four varieties of okra pods were determined by moisture content levels of 7%, 14%, 21% and 28% (wet basis) which are useful in the design of its processing, handling and storage equipment. The properties determined and mean values were length (107.97mm), diameter (35.17mm), mass(13.27g), true density(0.26gcm^{-3}), bulk density (0.18gcm^{-3}), porosity(58.06%), projected area(723.23mm^2), surface area(2627.55mm^2) and shape (conic/ribbed). The axial dimensions, individual pod mass, true and bulk densities increased as moisture content increases between 7% and 28% w.b., for the four varieties.

Habtamu et al. (2015)mentioned that okra (*Abelmoschus esculentus)* is an important vegetable crop grown in tropical and subtropicalparts of the world. Okra is a multipurpose crop due to itsvarious uses of the fresh leaves, buds, flowers, pods, stems and seeds. Okra immaturefruits, which are consumed as vegetables, can be used in salads, soups and stews, freshor dried, fried or boiled. Okra seeds are a potential source of oil, with concentrations varyingfrom 20% to 40%. Okra seed oil is also a rich source of linoleic acid, a polyunsaturatedfatty acid essential for human nutrition. Okra has been called "a perfect villager'svegetable" because of its robust nature, dietary fiber, and distinct seed protein balance ofboth lysine and tryptophan amino acids.

Abelmoschus esculentus, formerly known as Hibiscus esculentus, is a plant of the Malvacae family. It is an integral part of the diet of Africa and India as well as of other countries with the worldwide production of okra estimated to be close to 7 million MT, grossing close to an estimated US$ 4.4 billion in 2010 .

Okra seeds are considered a high-protein oilseed crop that can be used to complement other protein sources (Bryant et al., 1988).

Okra (*Abelmoschus esculentus (L.) Moench*), is an important vegetable crop of the tropical and subtropical regions of the world. In Egypt, it is one of the most popular vegetables and considered a valuable source of calcium, iron and vitamins. It has been grown for its edible green pods which can be used as fresh, canned, frozen, or dried food. The seed is the prime factor that determines the quantitative and qualitativecharacteristics of the crop that is going to be harvested later on .

The totalreduction of okra was 4.8 million ton pods all over the world in which India contributes 70%, Nigeria 15%, Pakistan 2%, Ghana 2%, Egypt 1.7% and Iraq 1.7% (Gulsen et al.,2007).

Fresh pods contain 88% water, 2.1 g. protein, 0.2 g.

Fat, 8 g. carbohydrates, 1.7 g. Fiber, 84 mg calcium, 90 mg phosphorus, 1.2 mgiron, 185 g B-carotene, 0.04 mg thiamine, 0.08 mg riboflavin, 0.08 niacin and 47 mg ascorbic acid (Tindall, 1983) but the protein in seeds varies between 15% and 26% and edible oil of more than 14% (NARP, 1993).

In Egypt, there are many genotypes of okra scattered in different parts of the country having diverse characteristics. In A. R. Egypt the cultivated area of okra during 2009 is about 22203 feddans produced nearly 134665 metric tons with an average of 6.065 ton\Fed (Economic Affairs Sector, 2010).

Shalan et al. (2011)mentioned that the field trial was done in the summer season of the two years 2007 and 2008 to evaluate and identify 9 Egyptian okra genotypes. The evaluation included the vegetative growth (plant height, number of branches per plant, leaf shape and leaf colour), flowering (earliness, node number to the first flower and colour of flower), yield of fresh pods (total number and weight per plot), fresh pod characteristics (length, diameter, mucilage, total sugars) and dry seed (index, volume, density, germination%, and total protein). The 9 genotypes, however, differ in the majority of these morphological and chemical characteristics.

Sowing date is an important factor where growers start cultivation okra from January onwards as an off-season, it has a great impact on seed yield and quality of okra, no germination occurs below 16℃. A monthly average temperature between 21℃ to 30℃ is considered appropriate for growth, flowering and pod development (Moniruzzaman et al., 2007; El-Waraky, 2014).

Yadav and Dhankar (2007)indicated that higher seed yield and germination percentage were recorded from okra pods harvested at the lower position on the plant. Hedau et al. (2010) reported that maximum germination and vigour was exhibited by the seeds obtained from fruits positioned at middle nodes, closely followed by seeds collected from the lower portion of the plant. However, seeds obtained from the upper fruits showed a poor seed yield and quality.Fertilization, in general and particularly with phosphorus, is considered one of the major factors that greatly affect seed yield and quality of okra (Sadat, 2000).

Singh (2002) and El-Shaikh (2005) found that fruit length, number of fruits/plant, number of seeds/fruit and 1000-seed weight recorded the highest mean values with the highest phosphorus rate.

Okra immature fruits (pods), which are consumed as vegetables, can be used in salads, soups and stews, fresh or dried, fried or boiled (NdunguruandRajabu, 2004).

According to Diaz-Franco et al.(1997), in addition to yield, fruit quality plays an important role in okra productivity and marketability. Criteria defining fruit quality are not completely clear except for the characteristic pod length, which is indicated by the United States Department of Agriculture.

Several desirable quality characteristics of okra fruit are length, diameter, greenness, mucilage and fiber content. Industry and commercial preference is oriented to fruits 8.9-12.7 cm long (medium), although smaller fruits are commonly accepted. A specific greenness and fruit diameter are also required, but they are often arbitrarily indicated (e.g., very dark and reduced fruit diameter are the most preferred) (Díaz-Franco et al., 1997).

According to FAO database, the five highest okra producing countries in 2008 were India, Nigeria, Sudan, Iraq and Côte D'Ivoire (FAOSTAT, 2010). Particularly, in India okra has a vast potential as one of the foreign exchange earner crops, since it accounted for about 60% of the export of fresh vegetables excluding potato, onion and garlic (Sankar et al., 2008).

In several parts of the world, okra cultivation has gained a place in urban and peri-urban areas partly because of the introduction of foreign high yielding varieties by seed companies (Ndunguru and Rajabu, 2004).

Most okra cultivars require about 4 months from sowing to harvest, though some early maturing varieties can produce fruits after 50 days in the tropics. At the

same time, these varieties are more tolerant to cooler temperate conditions, so they could be grown outdoors. These include ‘Clemson Spineless’, ‘Emerald’, ‘Long Green’ and ‘Green Velvet’. (Bisht and Bhat, 2006).

The first experimental hybrids of okra emerged in the USA at the beginning of the 90’s, as a new alternative production technology (Díaz-Franco et al., 2007). Okra hybrids show the advantage of a shorter life cycle and a higher yield. Annie Oakley is a hybrid, with bright green, angular pods. In spite of the numerous advantages of available okra commercial varieties and hybrids, the importance of traditional varieties has recently been pointed out by farmers, scientists and technologists of developing countries (Winarto and Ardhianto, 2007).

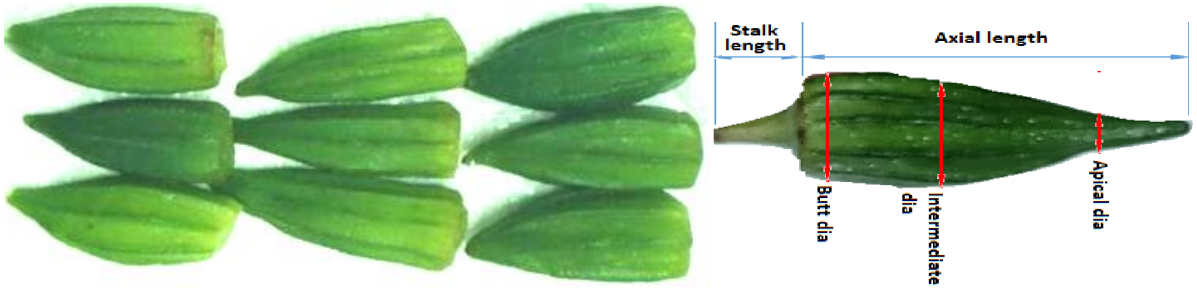
The objective of the present study was: a) to classify okra (*Abelmoschus esculentus*) fruits belonging to (Egyptian variety) according to their length by characterizing their measure dimensions by actual and prediction methods; b) to characterize color quality attributes of okra fruits to obtain okra color using different extraction color pixel and color area, in order to assess the best use of each one, for achieving the highest seed production with good quality in okra pods.

2 Materials and methods

2.1 Sample preparation

2.1.1 Plant material

Okra (*Abelmoschus esculentus* L. Moench) plants were fielded-grown in theExperimental Research Station, which belongs to the Horticulture Research Institute, Agricultural Research Center, Ministry of Agriculture, Mansoura Governorate, Egypt,to evaluate and measure, dimensions and color of okra (*Abelmoschus esculentus L.*, Moench) morphologically. The present study was carried out during the summer season of 2020. For the purposes of the present work, okra fruits were harvested from February, 15th of February, 25th, depending on the material. Soft and mature okra pods were grown in Mansora (Dakhlia, Egypt) and obtained from local market.



(a) Okra pod samples (b) linear dimensions of okra pods

Figure1 Okra pod samples and its linear dimensions

Okra pods were harvested early in the morning and immediately carried to the laboratory. Fruits showingphysical damage and/or disease symptoms were discarded. Pods (100 fruits) were classified according to their length (cm).Figure 1 shows okra pods with different length, diameter and color.

2.1.2 Cleaning

Cleaning of okra generally involves the elimination of leaves, stem sections, broken pods, insect damage, and mechanical injury from the pods. This should be done in the packing area while the pods are spread on a flat surface.Okra should not be washed, since this would lead to a greater incidence of postharvest decay.

2.2 Measurements

2.2.1 Initial moisture content

Okra pods were procured from the local market and cleaned to remove foreign materials and impurities. Methods developed by Visvanathan et al. (2012),were used for sample preparation to obtain desired moisture content.

The moisture content method of the pods as brought from the market was determined by drying samples in an

air circulating oven set at 105 1C (7 2) for 24 h and was found to be 11.03% wet basis (w.b).

2.2.2 Pod length and diameter

Twenty fresh okra pods were randomly selected from the selected variety as samples. Figure 1 shows the fresh okra pod samples. Two linear dimensions of each pod namely the length and diameter were measured with a Vernier Caliper, reading to 0.01 cm,Pod length was measured as the distance from the fruit cap scar at the base to the tip end of the pod (USDA, 1997).

The diameter was estimated in the mid of the pod. According to this characteristic, the diameter (cm) of the fruits in the peduncle insertion zone was measured using a standard graduated scale Vernier calliper.

2.2.3Pod fresh weight

Mean fresh weight (g) of okra fruits was determined by weighing fruits individually in a digital analytical balance (±0.001 g). Reported values correspond to the average of at least 50 fruits per category and per cultivar. Determinations were carried out by a duplicate.

2.2.4 Pod Bulk density

The bulk density of a dry okra pod at different moisture content was determined by filling a container (open top rectangular box of 200 × 100 × 100 mm) of known self-weight to the brim with dry okra pod and weighed to determine the net weight of the pod. Uniform density was achieved by tapping the container 10 times in the same manner in all measurements, the bulk density was calculated as:

$$Pb = Ws / Wo \quad (1)$$

where,Pb is bulk density (gcm^{-3}), Ws is weight of sample (g) and Wo is volume occupied (cm^3).

2.2.5 Pod surface colour

This attribute is determined using a Minolta CR 300 colorimeter, with an 8 mm diameter measuring area. The instrument was calibrated with a standard white plate. Readings were conducted by directly applying the colorimeter head on the fruit surface. Colour was measured in 10 different okra pods and fruit size for each group. The co-ordinates recorded areR, G and B of the CIE scale in order to analyze the derived functions

2.3 Statistical analysis

Descriptive statistics were used to determine mean values and regression analysis was employed to describe the fruit size and color as physical properties.

3 Results and discussion

3.1 Physical properties

Some of the physical properties of Okra fruits were studied. The length, diameter, weight, volume, and density ranged from (2.63 to 5.50 cm), (1.43 to 2.11 cm), (2.12 to 9.72 g), (4.24 to 19.24 cm^3) and (0.17 to 0.66 gcm^{-3}), respectively. Also, the average of4.01 cm, 1.71 cm, 9.91 g, 0.64 $cm^3$and 0.44gcm^{-3}.

Okra fruits are harvested in physiologically immature state. Thus, commercial (or horticultural) maturityprecedes physiological maturity. Special care must be taken during all handling operations to prevent product damage and the associated loss of visual appearance, increased water loss, and increased decay (Cantwell andKasmire, 2002).

Table 1show some physical properties of okra pods

	Measure length, cm	Measure large diam.,cm	Area, cm2	Weight (g)	Volume, cm3	Bulk density, gcm3	L/D
Min.	2.63	1.43	1.61	2.12	4.24	0.17	1.83
Max.	5.50	2.11	3.50	9.72	19.24	0.66	2.69
Average	4.01	1.71	2.33	4.97	9.91	0.44	2.31

The obtained data clearly showed the existence of pod variations among the different physical properties of okra (Table 1). Thus, it was shown that the longest pod resulted in 5.50 cm, While, the shortest one was obtained in 2.63 cm, with no significant variation among the length in every group. On the other hand, the longest pod diameter existed of 2.11 cm. While, the shortest values exerted of 1.43 cm.

Studies on the physical characteristics revealed that maturity index in weight pods of okra,was the heaviest

one 9.72 g. While, that 2.12 g was the lightest. The determination of the pod volume showed that 19.24 cm^3possessed the largest pod volume while, 4.24 cm^3 was showed the smallest one. Concerning the okra pod density, it was clear that 0.66 gcm^{-3}were the highest ones and surpassed all the tested in this character. Meanwhile the 0.17 gcm^3exhibited the lowest ones.

Regarding the existed differences in the pod quality of the various genotypes, it is easy to say that the numbers of pods per plant depending on the best pollination and the amount of supply carbohydrates of the pods (Bakry, 2005).

Amount of stored carbohydrates in stem of flowering and its mobilization after flowering varies considerably among the various genotypes which could be related to the incidence of abscission and ability of the genotype to prevent pod drop (Adams et al., 1978) that affect the number of pods per plant and differences in the quality.

3.2 Measure length okra pod

Data illustrated in Table 1 reveals that the increment in pod length may be due to the effect of prevailing environmental conditions on flowering, different dates of sowing, pollination and subsequent pod development (Table1). Differences in pod length due to different dates of sowing were also reported by several workers, such as Hossain et al.(2003) and Muhammad et al. (2015). There was a significant increase in pod length at 40 days after anthesis as compared with the other harvest dates. Pod length was significantly influenced by fruits position. The highest value (6.10 cm) was observed with pods obtained from pods collected at 40 days after anthesisand middle pods, while the lowest value (2.42 cm) was obtained from upper pods.

From our point view, it has established the standards for grades of Egyptian okra for different uses. The “very small” group includes okra pods less than 2.57 cm (<2.57 cm) in length; the “small”group includes okra pods not less than 2.57 cm or more than 3.59 cm (2.57 to 3.59 cm); the “medium” class includes okra pods more than 3.59 cm and not more than 5.18 cm (3.59 cm to 5.18 cm) in length; and the “large” group includes okra pods more than 5.18 (>5.18 cm). While, the United States Department of Agriculture (USDA) has established the US standards for grades of okra for processing which are intended to apply only to okra pods delivered to a freezing or canning plant for processing purposes. In this guide, two grades are pointed out (U.S. N º1 and U. S. N º 2). A size classification is included in connection with the grade on the basis of specified lengths in inches. The “very small” group includes okra pods less than 1.75 inches (<4.4 cm) in length; the “small” (or baby) group includes okra pods not less than 1.75 inches or more than 3.5 inches (4.4 to 8.9 cm); the “medium” class includes okra pods more than 3.5 inches and not more than 5 inches (8.9 cm to 12.7 cm) in length; and the “large” group that comprises, unless otherwise specified, pods more than 5 inches (>12.7 cm) (Marsh et al., 1990).

As well as, provisions concerning sizing from the Thai Agricultural Standard (TAS 1501-2004) state three size codes as follows: size code 1 (pod length -excluding peduncle- >12-14 cm); size code 2 (pod length -excluding peduncle- >10-12 cm); size code 3 (pod length -excluding peduncle- ≤10 cm).Okra fruits are harvested at physiologically immature state. Thus, commercial (or horticultural) maturity precedes physiological maturity. Special care must be taken in all handling operations to prevent product damage and the associated loss of visual appearance, increased water loss, and increased decay (Cantwell andKasmire, 2002).

3.3 Measure pod diameter

From our point view, it has established the standards for grades of Egyptian okra for different uses. The “very small” group includes okra pods less than 1.25 cm (<1.25 cm) in diameter; the “small”group includes okra pods not less than 1.25 cm or more than 1.62 cm (1.25 to 1.62 cm); the “medium” class includes okra pods more than 1.62 cm and not ore than 2.30 cm (1.62 to 2.30 cm) in diameter; and the “large” group includes okra pods more than 2.30 cm (> 2.30 cm). The data in Table 2 reveal that the maximum pod diameter (2.52 cm), while, minimum pod

diameter (1.22 cm) this result maybe pointed to different sowing dates and pod position. This result is in conformity with that of Moniruzzamanet al.(2007)they reported that the maximum fruit diameter was recorded for sowing 15 April. Data in same table also shows that the pod diameter of okra plant was significantly influenced by harvest date. The highest diameter of the pod was observed by pods harvested at 40 days after anthesis, and collect pods from middle positions. While, the lowest pod diameter was observed from pods which were harvested at 50 days after anthesis and collect pods from lower positions.

Concerning fruit diameter, LV and Clemson Spineless fruits had similar diameters (1.6-2.1 cm), showing LV fruits lower L/D ratio. Amongst the assayed material, Emerald cultivar had the highest L/D ratio,would be suitable for processing purposes.

The practical guide to export okra to USA(IICA, 2006) mentions that the minimum standards for okra pods specify about half an inch (1.27 cm) in diameter for fruits classified into U.S. N º1.

3.4 Ratio of L/D for okra pods

From our point view, it has established the standards for grades of Egyptian okra for different uses. The "very small" group includes okra pods less than 1.83 (<1.83) in L/D ratio; the "small"group includes okra pods not less than 1.83 or more than 2.31 (1.83 to 3.21); the "medium" class includes okra pods more than 3.21 and not ore than 2.69 (2.31 to 2.69) in length; and the "large" group includes okra pods more than 2.69 (> 2.69). The data reveal that the maximum L/D of the okra pod (> 2.69), while, minimum L/D of the okra pod(< 1.83), according to concerning fruit diameter, okra fruits had similar diameters, showing that sample fruits lower L/D ratio. Amongst the assayed material, while, fruits have bigger diameter, the okra sampleshad the highest L/D ratio. D áz-Franco et al. (1997) have pointed out that some okra processing companies in South Texas require small diameter and fruit length comprised between 8.9-12.7 cm; smaller fruits are often accepted but bigger fruits are rejected. Taking into account these criteria, cultivars Clemson Spineless and Emerald would be suitable for processing purposes.

Annie Oakley II and Clemson Spineless fruits were classified mostly in correspondence with the "very small", "small" and "medium" groups of the USDA classification. Emerald fruits were divided into a higher number of categories and in this case the proposed classification showed a better adjustment with the USDA categories (Table 1)

According the previous results, the classification based on fruits length or diameter or L/D was intended to establish a theoretical relationship with the use assigned to the product. Thus, smaller whole fruits could be used for canning or pickling. Fruits of intermediate size would be suitable for fresh consumption. On the other hand, larger fruits could be processed into slices.

3.5 Relationship between measure and image diameter of okra pods

From image processing data of the pod diameter of okra fruit, it was found that the relationship between the measure and image of the diameter of okra pods has a high correlation (R^2 = 0.9117).So, it can establish the standards for grades of Egyptian okra, according to image processing of the diameter of okra pods. Therefore, the standard grading according to image diameter as follows: The "very small" group includes okra pods less than 1.22 cm (<1.22 cm) in diameter; the "small"group includes okra pods not less than 1.22 cm or more than 1.77 cm (1.22 to 1.77 cm); the "medium" class includes okra pods more than 1.77 cm and not ore than 2.52 cm (1.77 to 2.52 cm) in diameter; and the "large" group includes okra pods more than 2.52 cm (> 2.52 cm).

The following equation showed that the relation between the measure and image of the diameter of okra pods

$$y = 2.0726x - 1.7764 \text{in diameter} \quad (2)$$

where, y is the image diameter of okra pods, and x is the measured diameter of okra pod.

3.6 Relationship between measure and image length of okra pods

From image processing data of the pod diameter of okra fruit, it was found that the relationship between the measure and image of the length of okra pods has a high correlation (R^2= 0.9783).So, it can establish the standards for grades of Egyptian okra, according to image processing of the length of okra pods. Therefore, the standard grading according to image length as follows: The "very small" group includes okra pods less than 2.42 cm (<2.42 cm) in length; the "small"group includes okra pods not less than 2.42 cm or more than 4.08 cm (2.42 to 4.08 cm); the "medium" class includes okra pods more than 4.08 cm and not more than 6.10 cm (4.08 cm to 6.10 cm) in length; and the "large" group includes okra pods more than 6.10 (> 6.10 cm).

The following equation showed that the relation between a measure and image of length of okra pods.

$$y = 1.2075x - 0.7598 \quad (3)$$

where, y is the image length of okra pods, and $x$is the measured length of okra pod.

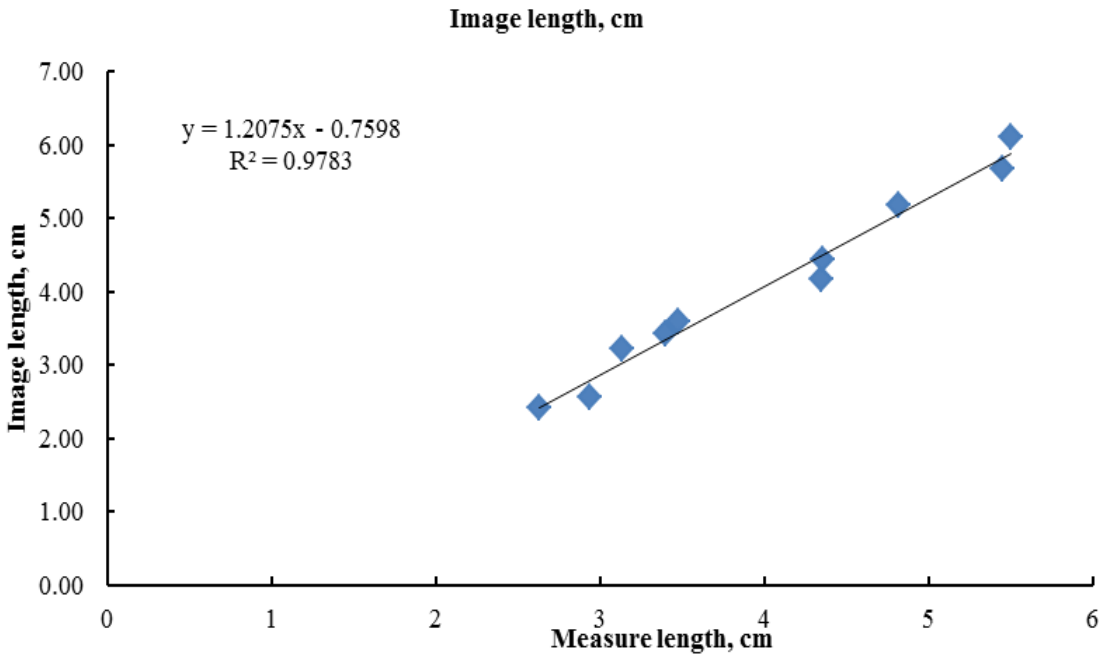
3.7 Relationship between measure and image of L/D ratio of okra pods

From image processing data of length and pod okra fruit, it was found that the relationship betweenthe measure and image of the L/D ratio of okra pods has a high correlation (R^2 = 0.9678).So, it can establish the standards for grades of Egyptian okra , according to image processing of the L/D ratio of okra pods. Therefore, the standard grading according to image processing as follows: the "very small" group includes okra pods less than 1.98 (<1.98) in L/D ratio; the "small"group includes okra pods not less than 1.98 or more than 2.28 (1.98 to 2.28); the "medium" class includes okra pods more than 2.28 and not ore than 2.55 (2.28 to 2.55) in length; and the "large" group includes okra pods more than 2.55 (> 2.55).

The following equation showed that the relation between a measure and image of the L/D ratio of okra pods

$$y = 0.136x + 1.886 \quad (4)$$

where, y is the image L/D, and$x$is the measure L/D.



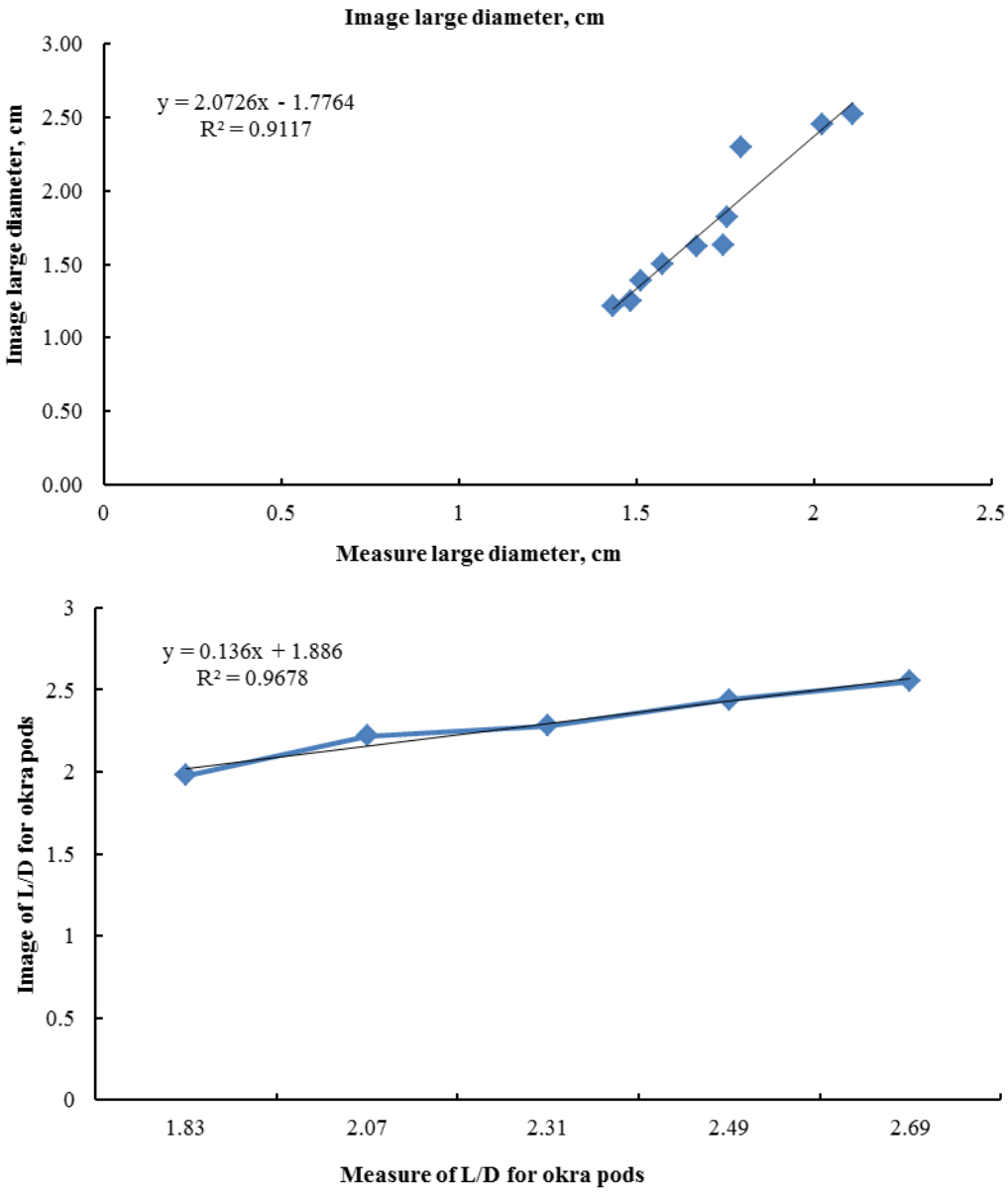


Figure 2 Relationship between measure and image of L/D ratio of okra pods

3.8 Color measure methods of okra pod

Data illustrated in Figure3 reveals that the measurements of color okra pods samples by two scales, one one them is line pixel and the second one is a rectangle. It was shown hat the difference between color values measuring by line and rectangle methods of okra pods

It was noticed that the measure color of the okra pod by the line pixel method were ranged as (Manimum and Maximum), from 15.4 to 29.5 values, 19.4 to 34.0 value, and 7.5 to 12.0 value for Red (R) and Green (G) and Blue (B) values, respectively. Meanwhile, the measure color of the okra pod by the Rectangle pixel method were ranged from 14.0 to 29.0 values, 18.0 to 33.0 value, and 7.0 to 11.2 value for Red (R) and Green (G) and Blue (B) values, respectively.

Also, the color average values of the okra pod by the line pixel method were 24.8, 28.6 and 9.87 values for Red (R) and Green (G) and Blue (B) values, respectively. Meanwhile, the measure color average value of the okra pod by the Rectangle pixel method were 22.7, 27.1 and 9.2 values for Red (R) and Green (G) and Blue (B)

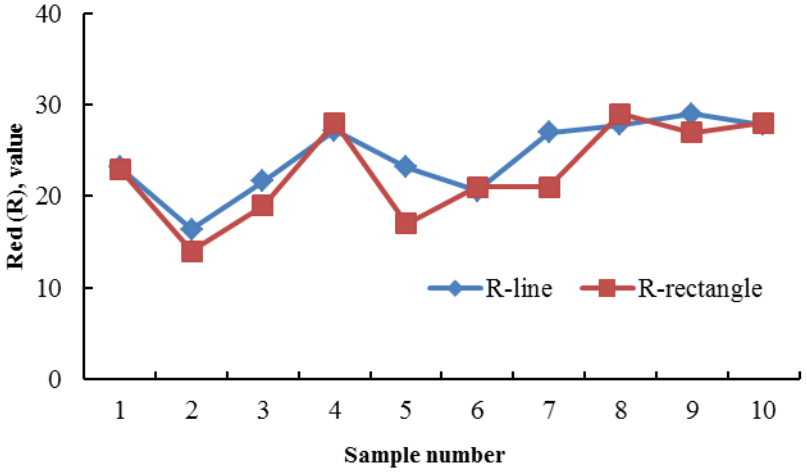
values, respectively.

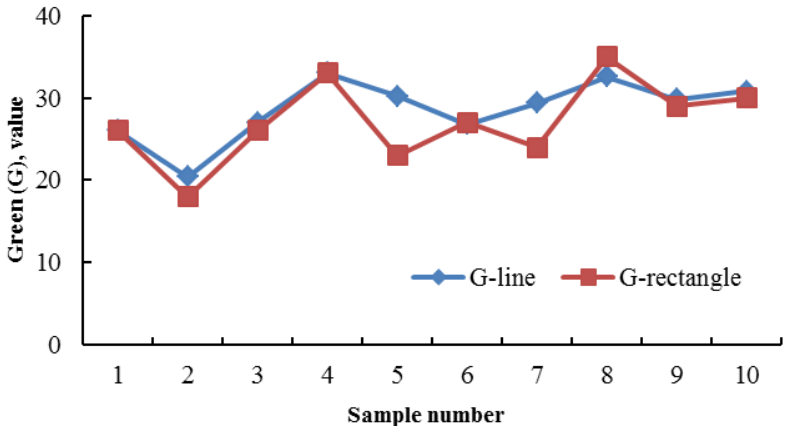
From previous results, it was shown that the difference percentage between color values, which measuring by line and rectangle pixel methods. It was noticed that the difference percentage of minimum values were about 9.09%, 7.22% and 6.67% , and for maximum valueswere about 1.69%, 2.94%, and 6.67%, and for average values were 6.89%, 5.24% and 6.79% for Red (R) and Green (G) and Blue (B) values, respectively

Regarding surface colour determinations (Figure3), Color scale of different color okra pods was showed no significant differences in the coordinate RGB.

According to the tender pods easily damage during handling, especially along the ribs. This leads to unsightly brown and black discolouration. So, the pods should be tender and not fibrous, and have a colour typical of the cultivar (generally bright green). Therefore, immature green tender fruits should be picked 3rd to 5th day from the time of first pod formation or 3 to 7 days after flowering. Okra should be harvested when the fruits are bright green, the pods are fleshy and seeds are small. So, very important for knowing the harvest maturity, to well understood a difference between ripe and mature. Produce that is ripe is mature and ripe produce is ready for sale and use. Produce that is mature may or may not be ripe but will ripen if given the right conditions. The best example is the mature green tomato. These tomatoes are harvested when they are green, but at a stage where they will eventually turn red and soften somewhat.

Skin color factor is commonly applied to fruits, since skin colour changes as fruit ripens or matures. Some fruits exhibit no perceptible colour change during maturation, depending on the type of fruit or vegetable. Assessment of harvest maturity by skin colour depends on the judgment of the harvester, but colour charts are available for cultivars, such as apples, tomatoes, peaches, peppers, etc.





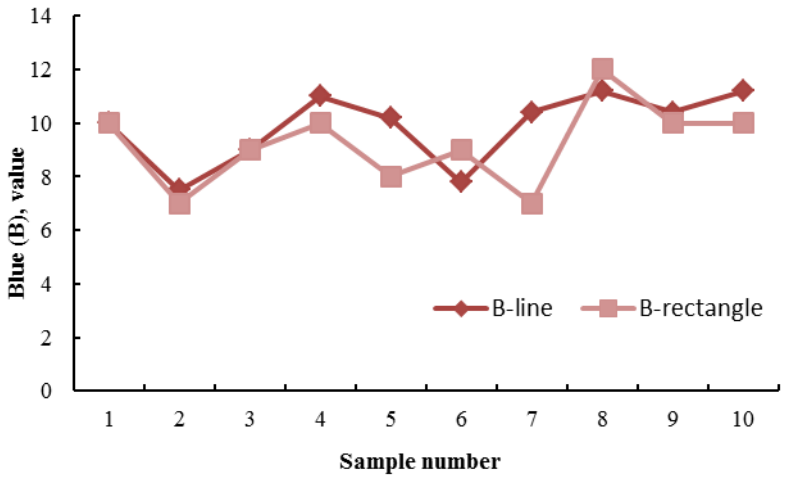


Figure 3 Measure surface color (RGB) of okra pods by line and rectangle methods

Note: Average RGB of pixel in line method of pod surface color, value

4 Conclusions

The investigation on various main dimensions using to measure methods (Line and rectangle) by image processingof okra pods revealed the following.

The length, diameter, weight, volume, and density ranged from (2.63 to 5.50 cm), (1.43 to 2.11 cm), (2.12 to 9.72 g), (4.24 to 19.24 cm3) and (0.17 to 0.66 gcm^{-3}), respectively of okra pods

The relationship between the measure and image of the diameter of okra pods has a high correlation (R^2 = 0.9117).So, it can establish the standards for grades of Egyptian okra, according to image processing of the diameter of okra pods. Therefore, the standard grading according to image diameter as follows: The “very small” group includes okra pods less than 1.22 cm (<1.22 cm) in diameter; the “small”group includes okra pods not less than 1.22 cm or more than 1.77 cm (1.22 to 1.77 cm); the “medium” class includes okra pods more than 1.77 cm and not ore than 2.52 cm (1.77 to 2.52 cm) in diameter; and the “large” group includes okra pods more than 2.52 cm (> 2.52 cm).

The relationship between the measure and image of the length of okra pods has a high correlation (R^2 = 0.9783).So, it can establish the standards for grades of Egyptian okra, according to image processing of the length of okra pods. Therefore, the standard grading according to image length as follows: The “very small” group includes okra pods less than 2.42 cm (<2.42 cm) in length; the “small”group includes okra pods not less than 2.42 cm or more than 4.08 cm (2.42 to 4.08 cm); the “medium” class includes okra pods more than 4.08 cm and not more than 6.10 cm (4.08 cm to 6.10 cm) in length; and the “large” group includes okra pods more than 6.10 (> 6.10 cm).

The relationship betweenthe measure and image of the L/D ratio of okra pods has a high correlation (R^2 = 0.9678).So, it can establish the standards for grades of Egyptian okra, according to image processing of the L/D ratio of okra pods. Therefore, the standard grading according to image processing as follows: the “very small” group includes okra pods less than 1.98 (<1.98) in L/D ratio; the “small”group includes okra pods not less than 1.98 or more than 2.28 (1.98 to 2.28); the “medium” class includes okra pods more than 2.28 and not ore than 2.55 (2.28 to 2.55) in length; and the “large” group includes okra pods more than 2.55 (> 2.55).

The difference percentage between color values, which measuring by line and rectangle pixel methods. The minimum values were about 9.09%, 7.22% and 6.67%, and for maximum valueswere about 1.69%, 2.94%, and 6.67%, and for average values were 6.89%, 5.24% and 6.79% for Red (R) and Green (G) and Blue (B) values, respectively

According to measure of color and size of okra fruits, the measurements considering visual means as aMaturity index of okra fruits.

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