academicJournals

Vol. 12(51), pp. 7092-7098, 18 December, 2013
DOI: 10.5897/AJB10.1751
ISSN 1684-5315 ©2013 Academic Journals
http://www.academicjournals.org/AJB

African Journal of Biotechnology

Full Length Research Paper

Effect of accessions on the chemical quality of fresh pumpkin

Zinash, A., Workneh, T.S.* and Woldetsadik, K.

School of Bioresource Engineering and Environmental Hydrology, Faculty of Engineering, University of Kwa-Zulu Natal, Private Bag xo1, Pietermaritzburg, Scottsville 3209, South Africa.

Accepted 18 June, 2013

Twenty (20) fresh pumpkin fruits were assessed for dry matter, total soluble solid, total sugar, reducing sugar, titratable acidity, pH, ascorbic acid and sugar-to-acid ratio. Statistically significant (P < 0.01) differences were found for dry matter, total soluble solid, total sugar, reducing sugar, titratable acidity, ascorbic acid, pH and sugar to acid ratio for the 20 fresh pumpkin fruit accessions. Accession 8007 had the highest dry matter, total titratable acidity, total soluble solid and total sugar content. Accession 8007 was also found to have high concentration of ascorbic acid although pumpkin fruit accession 8807 had the highest ascorbic acid. Pumpkin accession 4707 had the highest amount of reducing sugar and titratable acidity while accession 7707 had the highest pH and total soluble solid/ total titratable acid (TSS/TA) ratio. Pumpkin accession 8007 was found to be superior variety with the highest nutritional value while accession 1307 and 3907 were found to be inferior to the accessions evaluated in this study.

Key words: Pumpkin, accession, Ethiopia, nutritional value.

INTRODUCTION

Pumpkin is among the economically most important vegetable crops worldwide and is grown in both temperate and tropical regions (Pitrat et al., 1999; Paris, 1990; Sanjur et al., 2002). It is originated from Central America (Maynard et al., 2001). It was dispersed to other continents by transoceanic voyagers at the turn of the 16th century and has become a familiar and important vegetable crop in many countries (Gray and Trumbull, 1983). Depending upon the species, virtually all parts of the plant can be used for food, including leaves, shoots, roots, flowers, seeds, and immature and mature fruits (Schippers, 2000). The succulent, tasty leaves, stems, fruit and nutritious seeds make pumpkin the most popular vegetable to millions of people, ranking as one of the three most widely eaten vegetables at homes and in restaurants (Abiose, 1999). In Ethiopia, farmers produce pumpkin traditionally in their gardens together with cereals, near fences, to creep on houses, marginal or waste land, on decaying hay and heap of cow dung. The pumpkin cultivars locally produced by farmer are not identified. Suitable agro-ecologies for pumpkin cultivation for better performance of cultivars, suitable fruit and seed storage method for the extension of the shelf life and different fruit utilization method was not identified and popularized. There is wide variation in fruit size, fruit weight, shape and rind color, vine length and branching, leaf size, quality of fruit and seed size.

Despite its importance, pumpkin has not gained adequate

*Corresponding author: E-mail: seyoum@ukzn.co.za. Tel: +27(0)33-2605490. Fax: +27(0)33-2605818.

Abbreviations: DM, Dry matter; **TSS,** total soluble solid; **TA,** titratable acidity; **AA,** ascorbic acid.

Table 1. List of pumpkin fruit accessions used for the study.

Number	Accession number	Origin/place of collection in Eastern Ethiopia
1	8007	Harar
2	7607	Harar
3	4707	Kulubi
4	4007	Kulubi
5	5207	Dire-Dawa
6	7807	Harar
7	3607	Hirna
8	8807	Lange
9	1907	Lange
10	8307	Lange
11	1407	Lange
12	6907	Jijiga
13	3407	Hirna
14	7207	Jijiga
15	2807	Dire-Dawa
16	7107	Jijiga
17	3907	Kulubi
18	9107	Kulubi
19	7707	Harar
20	1307	Lange

research attention in Ethiopia to harness its potential because most traditional Ethiopian vegetables do not figure very prominently in modern crop research and conservation program. The current rural development strategy of Ethiopia has given due attention to the development of vegetables production. Hence, bringing this vegetable under research stream would play a pivotal role in exploiting its potential. Since there is no research information and no work has been done on it in Ethiopia other than some characterization efforts at Haramaya University, so identifying different landraces of pumpkin that are grown in eastern Ethiopia and documenting their fresh quality is important. Accordingly, this study was initiated to generate information on fresh quality of the crop with the specific aim of determining chemical quality of pumpkin accessions.

MATERIALS AND METHODS

Experimental material

The pumpkin fruits were collected from the market based on their morphological characteristics and variation by taking the growing area into consideration. Pumpkin fruit accessions with seeds were collected from markets in eastern Ethiopia (*Jijiga, Dire-Dawa, Kulubi, Harar and Lange)* and twenty accessions (Table 1) were grown in the Haramaya University research station during 2007/2008 main growing season. All the 20 pumpkin accessions were produced in the same experimental plot in three replication. The University is located at latitude of 9° 26' N and longitude of 42° 03'east and an altitude of 1980 m.a.s.l. The rainfall of the area is bimodal (in April and August) type with an average annual rainfall of 790 mm. The mean annual temperature is 17°C with mean minimum and maximum temperatures of 3.8 and 25°C, respectively. The mean relative humidity is 50%, varying from 20 to 81% and the soil type of the area is well-drained deep clay loam type (Tekalign, 2005). After maturity of the fruits, 20 pumpkin accessions were used for fresh fruit quality assessment. Samples of three fruits from each accession (one fruit from each replicated plot) were taken for analysis.

Experimental design and procedures

The assessment of 20 fresh pumpkin fruit accessions for different quality parameters was made using completely randomized design with three replications. Three fruits were randomly selected from each of 20 pumpkin fruit accessions; one from each experimental plot. Each fruit was divided in to four parts, one fourth of which was used for fresh quality analysis.

Data collection

To determine dry matter (DM) content of the pumpkin, samples were chopped to very small size and dried in an oven at temperature of 70°C to a constant mass, and the dry matter content was calculated according to AOAC (1984). The total soluble solid (TSS) of pumpkin fruit was determined following the procedures described by Waskar et al. (1999). An aliquot of juice was extracted using a juice extractor (6001x Model No. 31JE35 6x.00777) and 50 ml of the slurry was filtered using cheesecloth. The TSS content was determined by Abbe refractrometer (B+S 60/70 Model No. A-90067, England) with a range of 0 to 32 °Brix, by placing 1 to 2 drops of clear juice on the prism. Between samples, the prism of the refractrometer was washed with distilled water and dried before use. The refractrometer was standardized against distilled water (0% TSS). The pH of fruit was measured using the method of

Table 2. The mean of DM, TSS, TS and RS content of pumpkin accessions collected from eastern Ethiopia.

Accession number	DM (%)	TSS (°Brix)	TS (g 100 g^{-1})	RS (g 100 g^{-1})
8007	11.00^{a}	10.03^{a}	9.002^{a}	4.785^{bc}
7607	10.60^{ab}	8.63^{bc}	7.696^{b}	5.235^{ab}
4707	10.30^{ab}	9.03^{b}	8.574^{a}	5.663^{a}
4007	10.00^{bc}	8.40^{bc}	7.437^{bc}	4.098^{d}
5207	9.70^{b-d}	8.00^{cd}	6.919^{c}	4.357^{cd}
7807	9.27^{c-e}	7.73^{cd}	6.818^{cd}	4.525^{cd}
3607	8.97^{d-f}	7.43^{de}	6.277^{de}	3.568^{e}
8807	8.83^{d-g}	7.06^{d-g}	5.207^{fg}	3.602^{e}
1907	8.50^{e-h}	7.23^{d-f}	5.692^{ef}	2.780^{fg}
8307	8.20^{f-i}	6.73^{e-h}	4.779^{gh}	2.976^{f}
1407	8.00^{g-j}	6.43^{f-i}	4.362^{hi}	1.958^{ij}
6907	7.80^{h-k}	6.27^{g-j}	4.147^{hij}	2.938^{f}
3407	7.60^{h-l}	6.13^{g-k}	3.935^{ijk}	2.510^{fgh}
7207	7.40^{i-m}	5.40^{j-l}	3.272^{lm}	2.352^{ghi}
2807	7.10^{j-n}	5.73^{i-k}	3.311^{klm}	1.643^{jk}
7107	6.90^{k-o}	6.07^{h-k}	3.541^{jkl}	2.093^{hij}
3907	6.70^{l-o}	4.10^{n}	2.178^{o}	1.074^{l}
9107	6.50^{m-o}	4.80^{l-n}	2.532^{no}	1.257^{kl}
7707	6.30^{no}	5.20^{k-m}	2.864^{mn}	1.778^{j}
1307	6.00^{o}	4.433^{mn}	2.262^{no}	1.109^{l}
SE (±)	0.22	0.23	0.16	0.13
CV (%)	4.65	5.79	4.22	4.17
LSD	0.85	0.86	0.60	0.48
Sign	P < 0.001	P < 0.001	P < 0.001	P < 0.001

Means followed by common letters in a column are not significantly different from each other at 0.001 level of significance. Sign, Level of significance.

Nunes and Emond (1999). An extract of an aliquot of juice was prepared, the aliquot of juice was first filtered with cheesecloth and the pH value of the pumpkin fruit juice was measured with a Metrohn 691 pH meter. Total titratable acidity (TA) of the fruit was measured according to Maul et al. (2000). An aliquot of pumpkin fruit juice was extracted from the sampled pumpkin fruit with the juice extractor. The aliquot of pumpkin fruit juice was filtered through cheesecloth and the decanted clear juice was used for the analysis. The TA expressed as percent citric acid was obtained by titrating 10 ml of pumpkin fruit juice with 0.1N NaOH to pink end point (persisting for 15 s). Ascorbic acid (AA) content was determined by the 2, 6- dichlorophenol indophenols methods (AOAC, 1970). An aliquot of 10 ml of fruit juice was diluted to 50 ml with three percent metaphosphoric acid in a 50 ml volumetric flask. The aliquot was titrated with the standard dye to a pink end point (persisting for 15 s).

Compositional sugar analyses were conducted on fruit from each cultivar. Reducing (RS) and total sugars (TS) were estimated by using the calorimetric methods (Somogyi, 1945). Clear juice (10 ml) was added to 15 ml of 80% ethanol, mixed, and heated in a boiling water bath for 30 min. After extraction, 1 ml of saturated lead acetate (Pb (CH_3COO) $2.3H_2O$) and 1.5 ml of saturated sodium hypophosphate (Na_2HPO_4) were added and the contents were mixed by gentle shaking. After filtration, the extract was made up to 50 ml with distilled water. An aliquot of 1 ml extract were taken and diluted to 10 ml with distilled water. Then, 0.5 ml aliquot of extract was taken and made up to 1 ml. To this, 1 ml of copper reagent was added in a test tube and heated for 20 min in a boiling water bath. After heating, the contents were cooled under running tap water without shaking. Arsenomolybdate color reagent were added, mixed, made up to 10 ml, and left for about 10 min to allow color development, after which the absorbance were determined by a spectrophotometer at 540 nm. For total sugar determination, sugar was first hydrolyzed with 1 N HCl by heating at 70°C for 30 min. After hydrolysis, the determination of total sugar was made by following the same procedure employed for the reducing sugar. Blanks were prepared using distilled water instead of extract. The sugar to acid ratio of the fruits was calculated by dividing TSS to TA of the fruits.

Data analysis

Analysis of variance was carried out using MSTAT-C statistical software package (MSTAT-C 1991). Means were compared using the least significance differences test at 5% probability level.

RESULTS AND DISCUSSION

Dry matter and total soluble solid

The DM contents of the pumpkin fruits differed significantly (P < 0.001) (Table 2). The DM content ranged between 6.0 and 11.0%. The fruit of accession 8007 had the highest DM content (11%) which was significantly higher than the DM content of all accessions except accessions 7607 and 4707. Pumpkin accession 1307 had the lowest DM content (6%). Such high variation in DM content of pumpkin fruit has also been reported by Paulauskiene et al. (2006) who studied the quality of pumpkin cultivar in relation to their electrochemical and antioxidant properties. The difference could be due to variation in starch content of the genotype of the pumpkin fruit; with high DM content there is high content of starch (Hazzard, 2006). According to this researcher, pumpkin fruit with high DM content and starch content was characterized by high TSS and lower fiber content.

Significant ($P < 0.001$) difference in fruit TSS content was obtained among the pumpkin accessions with a range varying between 4.1 and 10.3 ^{o}Brix (Table 2). Pumpkin fruit accession number 8007 had the highest TSS (10.03 ^{o}Brix.) which was followed by accession 4707 (9.033 ^{o}Brix) while pumpkin fruit accession number 3907 had significantly lower TSS (4.1 ^{o}Brix). The result of this study agreed with the reports of Murakami et al. (1992) and Sudhakar et al. (2003) who showed large variation in the TSS content of pumpkin cultivar that also varied from year to year.

In general, 45% of the accessions recorded DM and TSS value more than average of whole accessions while the top four accessions had DM and TSS value, 26.5 and 33.9%, more than average of all accessions. More than 85% of pumpkin fruit TSS content is sugar and it is highly related to the sensory quality of pumpkin fruit and it is used to screen pumpkin fruit (Cantwell and Suslow, 1998).

DM content and TSS were shown to be among the major traits affecting the quality of pumpkin (Cordenunsi et al., 2003; Sturm et al., 2003). Several publications reported that quality of cucurbit fruit was highly related to sucrose and TSS content of fruit (Monforte et al., 2004; Sinclair et al., 2006). In addition to the naturally occurring variation in sucrose levels within any particular cultivar, there are genetic differences among cultivars affecting fruit quality in terms of their TSS contents (Stepansky et al., 1999; Burger et al., 2002, 2006, Burger and Schaffer, 2007).

In this study, DM showed strong positive correlation with TSS ($r = 0.94$), total sugar ($r = 0.953$), reducing sugar ($r = 0.919$), ascorbic acid ($r = 0.624$) and TA ($r = 0.624$) (Table 4). The positive correlation of fruit quality and DM content of pumpkin fruit in agreement with previous reports of Hazzard (2006) and Paulauskiene et al. (2006). The positive correlation could be because of starch; the major component of DM is the substrate from which TSS, total sugar, reducing sugar is synthesize during maturation and ripening (Hazzard, 2006).

Sugar contents

The total sugar content of pumpkin fruit significantly ($P < 0.001$) varied among the fruit accessions (Table 2). In this study, the total sugar content of the accessions ranged between 2.178 to 9.0 g 100g $^{-1}$ fresh weight. Pumpkin accession 8007 recorded significantly higher total sugar (9.0 g 100g $^{-1}$) than all the accessions except accession 8007 and 4707. Pumpkin fruit accession number 3907 had the lowest total sugar content. Similar to that of DM and TSS, the top four accessions (accession 8007, 7607, 4707 and 4007) had about 62% more total sugar over the average of all accessions while accession 1307 recorded the least values total sugar. The result of this study agrees with the findings of Sudhakar et al. (2003) who reported that reducing sugar content of pumpkin fruit significantly varied from cultivar to cultivar. Cantwell and Suslow (1998) also reported variations in total sugar contents among 36 varieties of pumpkin and indicated that sugar is the major component of TSS and it determines the flavor and sensory quality of pumpkin fruit.

Analysis of variance also revealed significant difference ($P < 0.001$) in the reducing sugar content of the pumpkin fruit accessions (Table 2). The reducing sugar content of the accessions ranged between 1.074 and 5.663 g 100g^{-1}. Pumpkin accession 4707 had the highest reducing sugar content which was followed by pumpkin accession 7607 (5.235 g 100 g^{-1}) while pumpkin accession 3907 had the lowest reducing sugar content. The result of reducing sugar in this study agrees with the finding of Murakami et al. (1992) and Culpepper and Moon (1945) who reported pumpkin fruit sugar content especially reducing sugar have high relation with sweetness of the fruit. Correlation analysis also showed that reducing sugar content of the pumpkin fruit accessions was strongly associated with TSS ($r = 0.903$), total sugar ($r = 0.941$) and DM ($r = 0.919$). The reason for positive correlations of reducing sugar to these parameters was that reducing sugar is a component of total sugar and TSS. Reducing sugar is also the substrate from which TA is synthesized within the fruit (Sakiyama and Stevens, 1976).

Ascorbic acid

Pumpkin fruit accession showed highly significant ($P < 0.001$) variation in ascorbic acid content at harvest (Table 3). The ascorbic acid content ranged between 4.81 mg 100 g^{-1} for accession number 7207 and 9.1 mg 100 g^{-1} for accession 8807. Overall, 50% of the accessions had ascorbic acid contents more than the average for all (7.01 mg 100 g $^{-1}$) while the cultivar with the highest ascorbic acid content recorded 29.8% over the average. Similar result reported by Sudhakar et al. (2003) indicated that ascorbic acid content of pumpkin vary from cultivar to cultivar. Many researchers reported that pumpkin provides a valuable source of ascorbic acid that have a major role in nutrition in the form of vitamin C as antioxidants (Duke and Ayensu, 1985; Sudhakar et al.,

Table 3. Mean value of fruit chemical composition in 20 pumpkin accessions collected from eastern Ethiopia.

Source of variation (accession)	Ascorbic acid (mg/100 g)	TA (%citric acid)	pH	TSS/TA
8007	8.700[a-c]	1.723[ab]	6.257[i]	5.818[a]
7607	7.900[c-f]	1.727[ab]	6.023[j]	5.000[b-e]
4707	8.500[a-d]	1.733[a]	5.920[j]	5.212[a-c]
4007	7.300[f-i]	1.620[bc]	6.560[fg]	5.184[a-d]
5207	7.700[d-g]	1.630[abc]	6.497[gh]	4.908[b-e]
7807	7.500[e-h]	1.653[ab]	6.340[hi]	4.677[b-e]
3607	8.900[ab]	1.490[de]	6.690[d-g]	4.990[b-e]
8807	9.100[a]	1.540[cd]	6.600[fg]	4.588[c-e]
1907	5.600[m-p]	1.350[fg]	6.750[b-f]	5.359[ab]
8307	5.400[n-p]	1.450[def]	6.643[e-g]	4.643[b-e]
1407	7.100[f-j]	1.200[hi]	6.837[a-e]	5.371[ab]
6907	6.933[g-k]	1.410[ef]	6.710[c-g]	4.444[de]
3407	8.200[b-e]	1.300[gh]	6.777[a-f]	4.711[b-e]
7207	4.800[p]	1.237[hi]	6.823[a-e]	4.368[e]
2807	5.133[op]	1.143[ij]	6.933[a-c]	5.013[b-e]
7107	6.700[h-l]	1.223[hi]	6.853[a-e]	4.961[b-e]
3907	5.833[l-o]	1.193[hi]	6.880[a-d]	3.429[f]
9107	6.500[i-l]	1.080[jk]	6.940[ab]	4.446[de]
7707	6.300[j-m]	0.9000[l]	6.993[a]	5.840[a]
1307	6.100[k-n]	1.020[k]	6.950[ab]	4.349[e]
SE (±)	0.21	0.02	0.05	0.19
CV (%)	5.15	2.88	1.33	6.91
LSD	0.796	0.099	0.198	0.742
Significance	P < 0.001	P < 0.001	P < 0.001	P < 0.001

Means followed by common letters in a column are not significantly different from each other at 0.001 level significance.

Table 4. Correlation of chemical composition parameters of fresh pumpkin fruit

	DM	TSS	TSU	RS	AA	TA	pH
DM	1						
TSS	0.940(***)	1					
TSU	0.953(***)	0.965(***)	1				
RS	0.919(***)	0.903(***)	0.941(***)	1			
AA	0.624(***)	0.609(***)	0.633 (***)	0.631(***)	1		
TA	0.624(***)	0.886(***)	0.912(***)	0.927(***)	0.61(***)7	1	
pH	-0.854(***)	-0.814(***)	-0.870(***)	-0.907(***)	-0.573(***)	-0.864	1
TSS/TA	0.376(**)	0.579(***)	0.467 (***)	0.34(**)	0.230(NS)	0.149 (NS)	-0.240(ns)

*Significant at P <0.05, *** significant at P< 0.01 and **significant at P < 0.001. DM, dry matter; TSS, total soluble solid; TSU,

2003) suggesting the potential of cultivars assessed in this study.

Ascorbic acid had significant and positive correlation with DM (R=0.624), TSS (r = 0.609), total sugar (r = 0.633), reducing sugar (r = 0.631), TA (r=0.617) and sugar to acid ratio (r = 0.941) indicating that most of the valuable quality attributes were associated and selection could be made based on one of these trait for ease of screening pumpkin genotype.

Titratable acidity

Analysis of variance revealed significant (P < 0.001) difference in TA of the pumpkin fruit accessions (Table 3). The value ranged between 0.9 and 1.73% for pumpkin accession 7707 and accession 7607, respectively. The result of this finding agreed with the finding of Davies and Hobson (1981). In a comparative study, Hurst et al. (1995) also found TA for six pumpkin genotypes in the range of 0.9 to 1.75% which is in agreement with the present study. Many studies support the idea that organic acids are produced within the fruit from stored carbohydrate material and that large sized pumpkin fruits with high DM content and TSS also have high acidity (Sakiyama and Stevens, 1976; Tittonell et al., 2001). High DM content and TSS also have high TA (Sakiyama and Stevens, 1976; Tittonell et al., 2001) which is inline with the present result. TA of pumpkin fruits in this study was also observed to have strong positive correlation with DM (r = 0.928), TSS (r = 0.886), total sugar (r =0.912) and reducing sugar (r = 0.927). Similarly, Saliba-Colombani et al. (2001) have also shown that fruit quality like sugar (primarily reducing sugars) was positively correlated to TA since it is synthesized within the fruit from stored carbohydrate.

pH of pumpkin

Table 3 displays the pH value of the 20 fresh pumpkin fruit accessions. Significant (P < 0.001) difference in pH values was observed among the accessions which ranged between 5.920 and 6.993. The highest pH value was recorded in pumpkin accession 7707 which did not significantly differ from pH values of 40% of the remaining accessions. This result appeared to be close to the pH values of pumpkin reported by Paulauskiene et al. (2006) varying between 5.87 to 6.99. Atherton and Rudich (1986) noted that there is a tremendous variation among pumpkin genotypes for pH and titratable acids. Paulson and Stevens (1974) showed that pH was highly negatively correlated with TA which agrees with the present result (r =0.864). The pH value of the pumpkin fruit accessions was observed to have strong negative correlation with DM content (r =-0.854), TSS (r =-0.814), total sugar (r = -0.870) and reducing sugar (r = -0.907). The reason for the negative correlation of pH value to these parameters could be because titratable acids is synthesized from stored carbohydrate within the fruit (Sakiyama and Stevens, 1976), so as fruit DM, TSS and sugar content increases, the content of TA also increases. Since TA has inverse relationship with pH value, so the negative relationship could be due to the increment of TA.

Total soluble solid to titratable acidity ratio

TSS to TA ratio varied significantly (P < 0.001) among the pumpkin fruit accessions (Table 3). The TSS/TA ratio of accessions ranged between 3.429 for accession 3907 and 5.840 for accession 7707. TSS to TA ratio of fruit and vegetable shows the balance of sugar to acid of fruit and vegetable. Although, the perception of flavor is influenced by many factors, taste is one of the most important components determined by sugars and acids (Malundo et al., 1995). Hurst et al. (1995), Daniel et al. (1995) and Harvey et al. (1997) reported that the sensory quality of pumpkin fruit is influenced by sugar and acid and their ratio is used in screening of pumpkin for sensory quality. Hence, the variation in TSS/TA ratio observed in this study indicate the presence of great potential in the local pumpkin genotypes for future improvement of this crop. Many researchers report that the TSS, TA and sugar content of pumpkin have strong relation and affect the flavor of pumpkin fruit (Cantwell and Suslow, 1998).

Conclusion

There was significant (P < 0.001) difference among accession in DM, TSS, total sugar, reducing sugar, TA, pH, ascorbic acid and sugar to acid ratio. Same pumpkin fruit accessions had superior compositional quality; pumpkin accession 8007 had the highest DM (11%), TSS (10.03 °Brix), total sugar (9.0 g/100 g); pumpkin fruit with accession number 8807 had the highest ascorbic acid (9.1 mg/100 g); pumpkin fruit accession number 4707 had the highest reducing sugar (5.66 g/100 g) and TA (1.73%) and pumpkin fruit accession 7707 had the highest TSS/TA ratio (5.84) and pH content (6.99). Generally, pumpkin accessions 8007, 8807, 4707 and 7707 had superior nutritional value while accession 1307 seemed to have lower concentrations of total soluble solid, total sugar and reducing sugar. Overall, accessions 8007, 8807, 4707 and 4007 are recommended for their superior nutritional quality.

REFERENCES

Abiose S (1999). Assessment of the extent of use of indigenous African foods introduced foods and imported foods in hotels and other commercial eating places in southwestern Nigeria. In: Africa's natural resources conservation and management surveys (J.J. Baidu-Forson, ed.). UNU/INRA, Accra. pp.50-52.

AOAC (1984). Official Methods of Analysis. 14th ed. Association of Official Analytical Chemists. Washington DC.

Atherton J, Rudich J (1986). The Tomato Crop. Chapman and Hall, London, U.K. p. 859.

Burger Y, Sa'ar U, Paris HS, Lewinsohn E, Katzir N, Tadmor Y, AA Schaffer (2006). Genetic variability for valuable fruit quality traits in Cucumis melo. Isreal J. Plant Sci. 54:233-242.

Burger Y, Schaffer AA (2007). The contribution of sucrose metabolism enzymes to sucrose accumulation in Cucumis melo. J. Am. Soc. Hortic. Sci. 132:704-712.

Cantwell M, Suslow TV (1998). Pumpkins and Winter squashes. Recommendations for maintaining post harvest quality. Perishables Handling Quarterly 94:15-16.

Cordenunsi BR, Nascimento JRO, Lajolo FM (2003). Physicochemical changes related to quality of five strawberry fruit cultivars during cool-storage. Food Chem. 83:167-173.

Culpepper CW, Moon HH (1945). Differences in the composition of the fruits of Cucurbita varieties at different ages in relation to culinary

use. J. Agric. Res. 71:111-136.
Daniel AL, Brecht JK, Sims CA, Maynard DN (1995). Sensory analysis of bush and vining types of tropical pumpkin. Proceed. Fla. State Hortic. Soc. 108:312-316.
Davies JN, Hobson GE (1981). The constituents of tomato fruit-the influence of environment, nutrition, and genotype. Food Sci. Nutr. 15:205-280.
Duke JA, Ayensu ES (1985). Medicinal Plants of China Reference Publications, Inc. ISBN 0-917256-20-4.
Gray A, Trumbull JH (1983). Review of DeCandolle's origin of cultivated plants. Am. J. Sci. 25:370-379.
Harvey WJ, Grant DG, Lammerink JP (1997). Physical and sensory changes during development and storage of Buttercup squash. N. Z. J. Crop Hortic. Sci. 25:341-351.
Hazzard R (2006). Pumpkin crop. Vegetable Notes for Vegetable Farmers in Massachusetts 17(20):20-32.
Malundo TM, Shewfelt RL, Scott JW (1995). Flavor quality of fresh market tomato (Lycopersicon esculentumMill.) as affected by sugar and acid levels. Postharvest Biol. Technol. 6:103-110.
Maul E, Sargent SA, Sims CA, Baldwin EA, Balaban MO (2000). Tomato flavor and aroma quality as affected by storage temperature. J. Food Sci. 65:1228-1237.
Maynard DN, Hochmuth GJ, Vavrina CS, Stall WM, Kucharek TA, Webb SE, Taylor TG, Smith SA (2001). Cucurbit production in Florida. p. 151-178. In: D.N. Maynard and S.M. Olson (eds.), Vegetable production guide for Florida. Univ. Florida, IFAS, Extension, Gainesville.
Murakami M, Himoto JM, Itoh K (1992). Analysis of pumpkin quality by near infrared reflectance spectroscopy. Department of Agricultural Engineering, faculty of agriculture, Hokkaido University, Sapporo.
Nunes MC, Emond JP (1999). Chlorinated water treatments affects post harvest quality of green bell peppers. J. Food Qual. 22:353-361.
Paris HS (1990). Genetic analysis and breeding of pumpkin and squash for high carotene content: Modern methods of plant analysis. Vegetable and Vegetable Production 16:93-115.
Paulauskiene A, Danilcenko H, Jariene E, Gajewski M, Seroczyńska A, Szymczak P, Korzeniewska A (2006). Quality of pumpkin fruits in relation to electrochemical and antioxidative properties. Vegetable crops research bulletin 65 research institutes of vegetable crops, skierniewice, Nowoursynowska, Warszawa 166:02-787
Paulson KN, Stevens MA (1974). Relationships among titratable acidity, pH and buffer composition of tomato fruits. J. Food Sci. 39:254-357.
Pitrat M, Chauvet M, Foury C (1999). Diversity, history and production of cultivated cucurbits. Acta Horticulturae 492:21-28.
Sakiyama R, Stevens A (1976). Organic acid accumulation in attached and detached tomato fruits. J. Am. Soc. Hortic. Sci. 101:394-396.
Saliba-Colombani V, Causse M, Langlois D (2001). Genetic analysis of organoleptic quality in fresh market tomato. 1. Mapping QTLs physical and chemical traits. Theory Appl. Genet. 102:259-272
Sanjur OI, Piperno DR, Andres TC, Wessel-Beaver L (2002). Phylogenetic relationships among domesticated and wild species of Cucurbita (Cucurbitaceae) inferred from a mitochondrial gene: implications for crop plant evolution and areas of origin. Proceed. Nat. Acad. Sci. 99:535-540.
Sinclair JW, Park SO, Lester GE, Yoo KS, Crosby KM (2006). Identification and confirmation of RAPD markers and and romonoecious associated with quantitative trait loci for sugars in melon. J. Am. Soc. Hortic. Sci. 131:360-371.
Stepansky A, Kovalski I, Schaffer AA, Perl-Treves A (1999). Interspecific classification of melons (C. melo L.) in view of their phenotypic and molecular variation. Plant Syst. Evaluation 217:313-332.
Sturm K, Koron D, Stampar F (2003). The composition of fruit of different strawberry varieties depending on maturity stage. Food Chem. 83:417-422.
Sudhakar PS, Jagdish AK, Upadhyay DR, Mathura R (2003). Ascorbate and carotenoid content in an Indian collection of pumpkin (Cucurbita moschata Duch. ex Poir). Cucurbit Genetics Cooperative Report. Indian Institute of Vegetable Research, Gandhi Nagar, Naria, India.
Tekalign T (2005). Response of potato to paclobutrazole and manipulation of reproductive growth under tropical condition. Ph D. Dissertation presented to University of Pretoria. South Africa. p.105.
Tittonell P, DeGrazia J, Chiesa A (2001). Effect of nitrogen fertilization and plant population during growth on lettuce (lactuca sativa L.) postharvest quality. Proceedings of the Fourth International Conference on Postharvest Science. Acta Horticulturae 553(1):67-68.
Waskar DP, Khedlar RM, Garande VK (1999). Effect of postharvest treatment on shelf life and quality of pomegranate in evaporative cooling chamber and ambient conditions. J. Food Sci. Technol. 2(36):114-117.