Uganda Journal of Agricultural Sciences, 2001, 19- 22
Printed in Uganda.

ISSN 1026-0919

Chemical and nutrient composition of tomato varieties grown in Uganda

A. N. Kaaya, A. Namutebi and J. Tujjunge
Department of Food Science and Technology, Makerere University,
P.O. Box 7062, Kampala

Abstract

The study determined the physico-chemical and nutrient composition of five major varieties of tomato (*Lycopersicon esculantum*) grown in Uganda. Bush, Money-maker, Maglope, Heinz and Italia tomato varieties were purchased at the red ripe stage of maturity from Nakasero market, Kampala and their pH, total soluble solids, total titratable acidity, proximate composition, vitamin (A and C) and mineral (sodium, potassium, calcium, magnesium, iron, zinc, manganese, copper and phosphorus) contents were determined. There was a significant difference for the physico-chemical, macro and micro nutrients ($P = 0.05$) of the tomato varieties except for the carbohydrate content. Bush variety had a high total soluble solids content and pH value indicating that it is good for processing of tomato sauce and ketchup. The nutrient composition of the tomato varieties in terms of protein, fat, minerals, fibre and vitamins varied a lot such that there was no single variety identified as having the highest levels of all these nutrients. This study revealed that some tomato varieties grown in Uganda are more important than others in terms of physico-chemical composition, individual nutrients and overall utilisation. This could be a basis for selection of these varieties for improvement by the breeders.

Key words: Tomato, physico-chemical, proximate composition

Introduction

Tomato (*Lycopersicon esculantum* L.) is one of the most important fresh fruits cultivated and consumed in the world. In The United States of America for example, the fruit is ranked number one in terms of contribution of vitamins and minerals to the diet (Wills *et al.*, 1989). The fruit may be utilised in different forms due to its pleasant flavour and nutritional value. It can be consumed fresh, included as major constituent in many prepared foods, canned, made into puree, soup, juice or Ketchup (Raymond, 1989).

In Uganda, there has been a tremendous improvement in the production and yield of tomato and there are five major varieties grown; Maglope, Heinz, Money-maker, Italia and Bush (FAO, 1995). These are grown almost all over the country with more yields coming from Buganda districts. Different tomato varieties could have different chemical and nutrient composition which in turn could have an effect on the fruit utilisation. This information too is very important for tomato breeders during selection of the varieties for improvement.

The objective of this study was therefore to determine and compare the physico-chemical and nutrient composition of the five tomato varieties grown in Uganda

Materials and methods

Bush, Money-maker, Maglope, Heinz and Italia tomato varieties were purchased at the red ripe stage of maturity on August 3, September 6 and October 12 1997 from Nakasero market, Kampala where the quality of agricultural produce is high and supplied by the same farmers.

Twenty (20) sound, uniformly sized fruits of each variety for each particular date were randomly selected, labelled and stored in a refrigerator for one day in the Department of Food Science and Technology, Makerere University. Thereafter, fruits were divided into three replicates and subjected to laboratory analyses.

Laboratory Analyses

Physico-chemical composition (total soluble solids, pH and total titratable acidity) were determined according to the methods recommended by Kirk and Sawyer (1991).

Total soluble solids determination

Fruits were chopped into small pieces and homogenised in a blender at high speed for 1 min. Total soluble solids were determined as % Brix from the extracted juice using a hand refractometer (ATAGÓ N-IE, Japan), range 0 - 32%.

pH determination

The homogenised tomato pulp used for total soluble solids was also used to assay for pH. The pH meter was adjusted accordingly and thereafter pH measurements were taken.

Total titratable acidity

Fruits were homogenised with 100 ml of distilled water in a blender at high speed for 1 min. The homogenate was filtered and 10 ml of the filtrate titrated against 0.1 M NaOH using 3 - 5 drops of phenopthalein indicator. Total titratable acidity as citric acid was calculated.

Determination of Proximate/nutrient composition

Moisture, protein, fat, fibre, ash, carbohydrates, vitamins (A and C) and mineral content (sodium, potassium, calcium, magnesium, iron, zinc, manganese, copper and phosphorus) were the proximate/nutrient composition determined.

Moisture content

Fruit moisture content was determined according to the method described by AOAC (1996). The weighed fruit sample was dried in an air oven (Gallenkamp, size-2, United Kingdom) at about 100°C to constant weight. The % loss in weight was taken as moisture content of the fruits.

Protein

Protein composition was determined using the digestion method (Nielsen, 1994). The digest was neutralised with 40% NaOH and thereafter titration with standardised 0.02N HCL to convert the borate ions to Nitrogen in the sample. A factor 6.25 was used when calculating total protein in the sample.

Fat

Using the Soxhlet method described by AOAC (1996), 2g of the dried fruit sample was mixed with 99.5% extraction solvent in thimbles which were later fixed on the Soxtec equipment (1043 Extraction Unit). Fat extraction was done by boiling the samples in the solvent for 15 min. The solvent was distilled off and the fat extracted was dried in air oven (Gallenkamp, size-2, United Kingdom) at 100°C for 30 min. and then allowed to cool in a desiccator. % fat composition was calculated by expressing the weight of the fat over sample weight.

Fibre

Crude fibre of the fruits was determined according to Kirk and Sawyer (1991). Sequential extraction of the sample with 0.25N H_2SO_4 and 0.25N NaOH was done and the insoluble residue collected by filtration. The residue was dried in air oven (Gallenkamp, size-2, United Kingdom), cooled and weighed. The difference in the weight lost was calculated and expressed as % fibre of the sample.

Ash

10g of the sample were ignited in a muffle furnace (Fischer isotemp, Model 184A) at 500 - 600°C for about six hours until carbon free as recommended by AOAC (1996). % ash content was computed as the weight of the ash formed over the weight of the fresh material.

Carbohydrates

Total carbohydrate was determined by the Difference Method (Nielsen, 1994). The difference that remained after subtracting all values of moisture, protein, fat, and ash from 100g of the sample was total carbohydrate.

Vitamin A and C

Vitamin A was determined using the Carr-Price Method according to Nielsen (1994). 5g sample was homogenised and saponified with ethanolic KOH for 30 min. Equal volumes of distilled water was added and the sample extracted with 1 - 1.5 volume of hexane. Vitamin A content was determined using a Spectrophotometer (Beckman, England) at wave length 482 nm, from a standard curve prepared using Vitamin A reference standards.

Vitamin c was determined using 2, 6-dichlorophenolindophenol method (AOAC, 1996) with slight modification. A 5g sample was homogenised with 10% TCA solution. The homogenate was transferred into a 100 ml volumetric flask and the volume made to the mark using distilled water followed by thorough mixing. 10 ml filtrate was taken and titrated with indophenol solution to a pink colour endpoint. Blank titration was done using 10% TCA and indophenol solution to the same colour endpoint. The vitamin c content was then calculated.

Mineral content

10g of dried fruit sample were digested by boiling in perchloric acid (50%) until the colour of the solution was clear (Kirk and Sawyer, 1991). Individual mineral elements were determined from standard curves using the Atomic Absorption Spectrophotometer (2280, Perkin Elmer) set at appropriate wave lengths.

Data Analysis

Data for each variety replicates for the three dates were compiled together and analysed by ANOVA using M.Stat. C. Package (Freed, 1989), and mean separation was done using LSD ($P = 0.05$).

Results

Tables 1 to 4 show the physico-chemical composition, proximate composition, mineral content and vitamin A and C content of the five varieties of the major tomato varieties grown in Uganda, respectively.

Bush variety had the highest pH value while the pH of Money-maker, Maglope, Italian and Heinz varieties did not differ significantly (Table 1). Values for the total soluble solids content (Table 1) were high for all the varieties compared to the average value of 3.8% Brix for the red-ripe tomato fruits reported by Willis et al. (1989). Titratable acidity varied significantly among the varieties but was highest in Maglope variety (table 1).

The proximate composition of the five tomato varieties (table 2) apart from carbohydrate content, varied significantly ($P = 0.05$). The fruit average moisture content of 95% (Table 2) lies within the 90-98% moisture content values of tomato fruits reported by Kader (1992). Purseglove (1984) reported that ripe tomatoes contain approximately 94% water, 1% protein, 0.1% fat, 4.3% carbohydrate and 0.6% fibre. These are comparable to the reported values of the tomato varieties grown in Uganda (Table 2).

Table 3 indicates that potassium was the most predominant mineral for all the varieties followed by magnesium and sodium, while copper was the least. According to Jen (1989) potassium is the most abundant mineral in fruits and vegetables, followed by calcium and magnesium, iron, phosphorus, boron, copper and zinc while others occur in minute quantities.

Results in Table 4 indicate that Italian variety had the highest content of vitamin A followed by Maglope while Money-maker and Heinz had the least. However, Maglope had the highest content vitamin c followed by Money-maker and Bush, while Heinz had the least. Purseglove (1984) reported that Vitamin c content of ripe tomatoes is 25 mg/100g which is within the 10-36 mg/100g range obtained from the five tomato varieties in the study (Table 4).

Table 1: Physico-chemical composition of the five tomato varieties grown in Uganda Physico-chemical composition

Variety	pH	TSS (°Brix)	TTA (%citric acid)
Bush	4.785 ± 0.050a	5 065 ± 0.076 a	0 08 0.0087 e
Money-maker	4.505 ± 0.050 b	4 235 ± 0 080 b	0.255 0.008 b
Maglope	4.525 ± 0.051 b	4.835 ± 0.075 a	0.365 0.0081 a
Italian	4.510 ± 0.050 b	4 100 ± 0 076 b	0.175 0.009 c
Heinz	4.575 ± 0.05 b	4.135 ± 0.075 b	0.120 0.008 d
LSD P = 0.05	0.1963	0 2612	0.000878

Values are means of three replicates for the three dates.
Values in the same column with the same letter are not significantly different (P = 0 05)
TSS - Total soluble solids
TTA - Titratable acidity

Table 2. Proximate composition of the five tomato varieties grown in Uganda

	Variety					
Nutrient (%)	Bush	Money-maker	Maglope	Italian	Heinz	LSD (P = 0.05)
Moisture	94 70 ± 0 190 b	95 30 ± 0.190 ab	95 45 ± 0.190 a	95 08 ± 0 190 ab	95.29 ± 0.190 ab	0.75
Protein	1.195 ± 0 068 a	0 730 ± 0 069 b	0 740 ± 0 069 b	0 750 ± 0 069 b	0.890 ± 0.069 b	0.2364
Fat	0.075 ± 0 005 e	0 135 ± 0 005 a	0 085 ± 0 005 d	0 100 ± 0 005 b	0.095 ± 0 005 c	0.00088
Fibre	0.525 ± 0 025 bc	0 610 ± 0 025 ab	0 500 ± 0 025 c	0 670 ± 0 025 a	0.595 ± 0.025 ab	0.0878
Ash	0.665 ± 0 036 a	0 580 ± 0.036 abc	0 465 ± 0 036 bc	0 440 ± 0 036 c	0.585 ± 0.036 ab	0.1521
Carbohydrate	2.840 ± 0.122 a	2.645 ± 0 122 a	2 760 ± 0 122 a	2.960 ± 0 122 a	2.535 ± 0 122 a	0.4809
Total sugars	0.310 ± 0.017 a	0 200 ± 0 017 b	0 260 ± 0 017 ab	0 270 ± 0 017 ab	0.255 ± 0.017 ab	0.0878

Values are means of three replicates for the three dates
Values in the same row with same letter are not significantly different.

Table 3. Mineral content of the five tomato varieties grown in Uganda

	Variety					
Mineral (mg/100g)	Bush	Money-maker	Maglope	Italian	Heinz	LSD (P = 0.05)]
Sodium	6 190 ± 0 255 b	7.835 ± 0 255 b	5 880 ± 0.255 c	7.840 ± 0.255 b	14.76 ± 0.255 a	0.01
Potassium	121 ± 4 0 464 b	111.4 ± 0.464 bc	144 9 ± 0.464 a	96.40 ± 0.464 c	105.90 ± 0.464 bc	1.822
Calcium	5 828 ± 0 280 e	9.040 ± 0.280 c	10 18 ± 0 280 b	7 130 ± 0.280 d	18.26 ± 0.280 a	1.100
Magnesium	11 29 ± 0 424 ab	10 14 ± 0.424 bc	12 25 ± 0 424 a	9.320 ± 0.424 c	9 050 ± 0.424 c	1.666
Iron	0 415 ± 0 021 c	0.670 ± 0.021 b	0 740 ± 0 021 b	0.500 ± 0 021 c	1.035 ± 0.021 a	0.0878
Zinc	0 155 ± 0 007 c	0 170 ± 0 007 a	0 140 ± 0.007 d	0 160 ± 0.007 b	0.120 ± 0.007 e	0.0008
Manganese	0.090 ± 0 006 e	0 140 ± 0.006 c	0.115 ± 0.006 d	0 150 ± 0.006 d	0.190 ± 0.006 a	0.00088
Copper	0 055 ± 0.002 c	0.060 ± 0.002 b	0.080 0 002 a	0 040 ± 0 002 d	0.030 ± 0.002 e	0.00087
Phosphorus	1 845 ± 0 061 b	1 045 ± 0.061 c	0.695 ± 0 061 d	3 460 ± 0.061 a	0.980 ± 0.061 c	0.2483

Values are means of three replicates for the three dates.
Values in the same row with same letter are not significantly different

Table 4. Vitamin A and C content of the five tomato varieties grown in Uganda

	Vitamin	
Variety	A (I.U/100g)	C (mg/100g)
Bush	1801. ± 0 2.856 b	13.93 ± 0.3461 c
Money-maker	844.3 ± 2.856 d	15.30 ± 0.3461 b
Maglope	1022.0 ± 2.856 c	35.67 ± 0.3461 a
Italian	2748.0 ± 2.856 a	11.40 ± 0.3461 d
Heinz	842.0 ± 2.856 d	9.53 ± 0.3461 e
LSD P = 0.05)	11.21	1.36

Values are means of three replicates for the three dates. Values in the same column with the same letter are not significantly different.

Discussion

There were significant differences in the physico-chemical and nutrient contents among the five major tomato varieties grown in Uganda. Bush variety had the highest pH and total soluble solids but least total titratable acidity indicating that it is good for processing of tomato sauce and ketchup (Potter, 1987). The rest of the varieties had their pH not significantly different but with a variation in total titratable acidity and total soluble sugars

Apart from carbohydrate content which was not significantly different, tomato varieties varied a lot in terms of nutrient composition such that no single variety was identified as having the highest amount of all the nutrients analysed. This may imply that these tomato varieties may be utilised differently.

Values of the physico-chemical and nutrient composition of the tomato varieties obtained were all within ranges reported by several researchers such as Gould (1983), Purseglove (1984) and Atherton and Rudich (1986).

Conclusion

This study revealed that tomato varieties grown in Uganda vary significantly in their physico-chemical and nutrient composition. Thus, the overall importance and utilisation, especially processing of these varieties could differ.

This information is very important as a basis for selection of these varieties for improvement by the breeders.

References

AOAC. 1996. Official Methods of Analysis of AOAC International. 16th Ed. Arlington, Virginia.

Atherton, J. G. and J. Rudich. 1986. The tomato crop as a scientific basis for improvement. Chapman and Hall Pub. Co. Ltd. London. pp. 28-50.

FAO 1995. Food and Agricultural Organisation Production Year Book. Basic data Branch. Statistics Division 00100, Rome, Italy.

Freed, R. D. 1989. MSTAT Computer Package, Version 2. 10. Crop and Soil Sciences Department, Michgan State University.

Gould, A. W. 1983. Tomato Production, Processing and Quality Evaluation, 2nd Ed. Longman, Great Britain pp. 30-33, 86-90.

Jen, J. J. 1989. Quality factors of Fruits and Vegetables: Chemistry and Technology. American Chemical Society, Washington, DC. pp. 181-182.

Kader A. A 1992. Quality and safety factors: Definition and evaluation for fresh horticultural crops. pp. 185-190. In: Kader A. A. (ed). Postharvest Technology of Horticultural Crops. 2nd edition, Publication 3311, University of California, Division of Agriculture and Natural Resources. Berkeley, CA.

Kirk, R. S. and R. Sawyer 1991. Pearson's Composition and Analysis of Foods. Longman Sci. Press London pp. 223-228.

Nielsen, S. S. 1994. Introduction to the Chemical Analysis of Foods. Jones and Bartlett Publishers International. 7 Melrose Terrace, London W6 7RL, England. pp. 142; 233 -246; 253.

Potter, N. N. 1995. Food Science 3rd Ed. CBS Publishers and Distributors, 485, Jain Bhawan, Bhola Nath Nagar Shahdara, Delhi-110032, India. p. 132.

Purseglove, J. W. 1984. Tropical Crops. Dicotyledons. Volumes I and 2 combined Longman Group Ltd. England. p. 535.

Raymond, A. T. G. 1989. Vegetable seed production. 2nd ed. Longman Group Ltd. London and New York pp. 38-50.

Willis, R. B. H., W. B. Mcglasson, D. Graham, t. H. Lee and E. G. Hall. 1989. Postharvest. An introduction to Physiology and Handling of Fruits and Vegetables. Van Nostrand Reinhold, New York, NY 10003. pp 3-21.