PHYSICO-CHEMICAL CHARACTERISTICS OF STORAGE-RIPENED MANGO (*MANGIFERA INDICA* L.) FRUITS VARIETIES OF EASTERN TANZANIA

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ABSTRACT

Two mango (Mangifera indica L.) *fruit varieties,* Dodo *and* Viringe*, from two localities of Eastern Tanzania, (Muheza in Tanga and Ifakara in Morogoro), were harvested as mature green fruits during early, mid and late season and allowed to ripen while stored at room temperature. The fruits were analyzed for their proximate composition (ash, titratable acidity, crude fat, crude fibre, moisture), reducing and total sugars content, ascorbic acid and total soluble solids content, concentration of four macro elements (Ca, Mg, K, Na) and seven heavy metals (Al, Cd, Cu, Fe, Mn, Pb, Zn). The results showed that the mango fruits had high moisture content (>65%), moderate acidity (0.20 - 1.30% c.a.), low crude fat content (0.20 g/100 g-fw), low crude fibre content (0.85 g/100 g-fw), low ash content of 0.55 g/100 g-fw, high reducing sugars amounts (10.5 – 21.3%), high total sugars content (10.5 – 21.3%), high soluble solids content (14.2 – 26.5%) and high ascorbic acid content (15.8-25.1%). Potassium was the major macro element present (209.5 mg/100 g-fw). Heavy metal concentrations in the fruits were very low indicating insignificant pollution of the fruits. Moisture, reducing sugars, total sugars, and soluble solids content in the mango fruits increased within the season and with ripening storage. The ascorbic acid and titratable acidity content increased as the season progressed but decreased during the storage ripening period. Minimal seasonal changes were observed for ash, crude fat and crude fibre contents of the fruits.*

INTRODUCTION

Fruits are foods rich in vitamins and minerals and supply arrays of colours, flavour, texture and bulkiness to the pleasure of eating. Fruits are essential for the proper maintenance of human health (Nakasone and Paull 1998). *Dodo* and *Viringe* mango (*Mangifera indica* L.) fruits are very popular seasonal fruits of East Africa as they are very delicious, sweet and juicy. In recognition of the importance of fruits as valuable food resources, increasing attention has been paid in recent years to study their physicochemical properties and seasonal variation.

Concern about heavy metal toxicity has resulted into the analysis of food and food products for such elements (Robinson *et al*. 1989). Levels of heavy metals, macro elements and other inorganic elements found in green leafy vegetables (Raja *et al*. 1997, Bahemuka and Mubofu 1999) have been reported that show the presence of toxic elements in fresh foods. Heavy metals dumped into the environment cause environmental pollution which affect plants and fruits. Other factors such as foliar sprays, irrigation practices (if plants are irrigated with water which contains these elements) may cause contamination of fruits. Plants that are grown near motor ways have been shown to accumulate heavy metals especially lead (Chhatwal *et al*. 1989). Some fruits (orange, mango, tangerine and papaya) in Tanzania are being cultivated close to roads and major highways (e.g. the Dar es Salaam-Tanga highway) which could be a source of contamination for these fruits. This study investigates the chemical and

physical characteristics of *Dodo* and *Viringe* mango (*Mangifera indica* L.) fruits from eastern Tanzania to establish the basic quality profile for the fruits.

MATERIALS AND METHODS

Fruit sample collection

Samples of mango (*Mangifera indica* L.) fruits, *Dodo* and *Viringe* varieties, were collected from Ifakara in Morogoro region and Muheza in Tanga region, Tanzania. During the fruiting season, fully mature ripe fruits were picked directly from trees in batches of five for the appropriate determinations. Only fruits that did not have/show any visual signs of bruises, cuts, blackening or infestation were selected for the study. Fruit samples were transported to the Chemistry Department laboratory, University of Dar es Salaam, for further investigation. The samples of mango fruits were harvested during early, mid- and late season of the fruit.

Analysis

The determinations of the different parameters in the fruits were done immediately upon arrival of the fruits to the laboratory and thereafter at successive intervals of two days from the day of harvesting of the fruits. These determinations were repeated for the early, mid and late season fruits.

Ash and Moisture

The ash and moisture content of the fruits were determined using an air oven according to standard methods as described in AOAC (1990).

Titratable acidity

Minced fresh fruit samples (10 g) were mixed with 200 cm^3 distilled water and boiled for 1 hour, cooled and the mixture then filtered. The filtrate (10 cm^3) was titrated with 0.1 M NaOH up to pH 8.1 using a pH meter as the titrimetric indicator. The results were expressed as percent citric acid (g citric acid/100 g-fw) (AOAC, 1990).

Crude fat

The weighed dried fruit sample was put into a thimble and covered with fat free cotton. The thimble was then put into the soxhlet apparatus. The flask was filled with 150 cm^3 petroleum ether and extraction was done for 16 hours or longer on a water bath. At the end the sample was dried at 100°C in an oven for 1 hour, then cooled to room temparature and re-weighed. The difference in the weights gave the fat-soluble material present in the sample. Determination was done in triplicate and the average value was recorded (Ranganna 1977).

Crude fibre

Crude fibre is determined from the residue remaining after the crude fat determination. Boiling sulphuric acid (200 cm^3) was added to the residue (2 g) in the digestion flask which was immediately connected to the condenser and heated for 30 minutes. The digested material was then filtered and washed thoroughly with boiling water until the washings were no longer acidic. NaOH solution was boiled under reflux and the washed material was added unto it. The contents in the flask was connected to the reflux condenser and boiled for 30 minutes. The material was then filtered and washed thoroughly with water followed by 15 cm^3 of alcohol. The contents were dried at 110 ^oC to constant weight, cooled in a desiccator and weighed. The material was ashed in the muffle furnace at a dull-red heat (450 ^oC) for 20 minutes, cooled and then weighed. The loss in weight represented the crude fibre amount (Ranganna 1977).

Ascorbic Acid

Ascorbic acid was determined by the method of titration using 2,6 dichloroindophenol following the procedure of AOAC (1990), method 967.21

Reducing and total sugars

The reducing sugars in the fruits were determined by method 939.03 of AOAC (1990) and the total sugars according to

Ranganna (1977).

Total Soluble Solids (TSS)
TSS was determined by a refractometer following Method 932.12 of AOAC (1990).

Determination of metals

Fresh fruit juice (20 cm^3) was mixed with 10 cm^3 conc. HCl and the solution made up to a volume of 100 cm^3 with distilled water. The solution was then centrifuged and used for determination of metals in the fruits. Appropriate dilution was done for elements present at high concentrations (MacHard *et al*. 1976). The determinations of metals were performed with a Perkin Elmer, model AAnalyst 300, Atomic Absorption Spectrophotometer (Perkin-Elmer 1994), at the Chemistry Department, University of Dar es Salaam.

RESULTS AND DISCUSSION
Titratable acidity (TA)
The titratable acidity values for the two varieties of mango fruits are presented in Table 1. *Dodo* mangoes had higher titratable acidity than *Viringe* mangoes throughout the season. During storage ripening there was a decrease in titratable acidity of the mangoes of 1.20 % c.a. to 0.40 % c.a. for the *Dodo* and 0.75 % c.a. to 0.25 % c.a. for the *Viringe*. The decrease in titratable acidity during ripening of mangoes has also been reported by Elahi and Khan (1983) and Mamiro *et al.* (2007). Agbo and Inyang (1995) observed a decrease of TA from 1.47 % c.a. to 0.18 % c.a. in Julie mangoes. Elahi and Khan (1983) reported a decrease from 2.12 % c.a. to 0.39 % c.a. in 'Anwar' mango variety after eight days of storage. Rathore et al. (2007) also reported a decrease in TA for the *Dosehari* mango during storage-ripening. Medlicott and Thomson (1985) found that the decrease in acidity was due initially to the high rate of loss of citric acid with only small losses of malic acid.

In citrus fruits, citric acid is the predominant acid though malic acid is also present in appreciable quantities (Echeverria and Ismail 1987 and Biale 1960). The minor acids normally detected were succinic, malonic, tartaric, benzoic, isocitric, aconitic, lactic and oxalic acids (Vandercook 1977). A direct relationship exists between the acidity of citrus fruit juices and the concentration of combined citric and malic acids (Chen *et al.* 1993), thus the reduction might also be due to the utilization of these acids in respiratory process (Nagar 1994).

Moisture
Data on moisture content of the *Dodo* and *Viringe* mangoes studied is presented in Table 1. Both mango varieties showed high moisture content that ranged from 56.3 to 86.1%. Overall, whole *Dodo* mangoes had higher moisture content than Viringe mangoes. The *Dodo* mango of Morogoro had higher moisture content than the *Dodo* mango of Muheza in Tanga. Early season fruits had the lowest moisture content while late season fruit had the highest moisture. The moisture content of the fruits increased during the eight-day room temperature storage ripening period. The *Dodo* mango from Morogoro has also been reported to have high moisture content (77.5 – 80.1%) during ripening by Mamiro *et al*. (2007).

Ascorbic acid
The results on ascorbic acid content of the fruits are presented in Table 1. The values ranged from 5.0 to 25.2 percent. Late season mango fruits had the highest values of ascorbic acid when harvested whereas early-season fruits had the lowest values during the season. *Viringe* mango had slightly lower ascorbic acid content than *Dodo* mango. The ascorbic acid content in the mango fruits decreased significantly during the ripening storage period, an observation also reported by Mamiro *et al*. (2007), and similar to the case of ripening medlar (*Mespilus germanica* L.) fruits (Aydin and Kadioglu 2001).

Table 1: Percent titratable acidity (%c.a.), moisture and ascorbic acid content of *Dodo* and *Viringe* mangoes of eastern Tanzania

Percent titratable acidity values (% c.a.)									
Storage time in days	***Dodo* mango from Ifakara, Morogoro**			***Dodo* mango from Muheza, Tanga**			***Viringe* mango from Muheza, Tanga**		
	SEASON			**SEASON**			**SEASON**		
	Early	**Mid**	**Late**	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**
0	1.30	1.20	0.90	1.90	1.75	1.50	0.95	0.75	0.50
2	1.25	1.10	0.85	1.85	1.60	1.40	0.95	0.65	0.45
4	1.20	0.75	0.80	1.80	1.50	1.00	0.80	0.55	0.30
6	1.00	0.50	0.60	1.65	1.20	0.91	0.60	0.40	0.25
8	0.85	0.40	0.45	1.60	1.00	0.80	0.50	0.25	0.20
Av. Dev.	± 0.07	± 0.09	± 0.08	± 0.15	± 0.10	± 0.15	± 0.15	± 0.06	± 0.14
Percent moisture content in mangoes									
Days	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**
0	65.1	76.2	81.2	62. 0	66.2	67.8	56.3	58.8	60.4
2	67.5	79.1	82.5	62.8	67.1	68.4	58.1	59.3	61.2
4	69.4	80.7	83.8	63.5	68.3	69.2	59.0	60.5	62.0
6	71.6	81.8	84.6	64.3	69.6	70.4	60.0	61.2	63.1
8	73.8	83.3	86.1	65.6	71.0	71.80	61.3	62.5	64.2
Av. Dev.	± 0.5	± 0.4	± 0.5	± 0.5	± 0.4	± 0.6	± 0.4	± 0.5	± 0.4
Percent ascorbic acid content in mangoes									
Days	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**
0	15.3	19.6	25.2	19.2	21.4	23.7	15.8	19.7	22.2
2	12.2	18.4	23.6	18.5	20.2	21.6	14.3	18.8	20.5
4	10.0	16.3	18.5	17.1	19.0	20.0	12.1	17.0	18.2
6	7.4	13.4	17.8	15.8	18.0	18.7	10.4	15.5	17.0
8	5.1	10.2	16.2	13.9	16.5	17.30	9.4	13.3	15.4
Av. Dev.	± 0.4	± 0.5	± 0.5	± 0.4	± 0.4	± 0.3	± 0.5	± 0.2	± 0.3

All data are the mean of five measurements ± standard error

Reducing sugars

The percent reducing sugars content in the mangoes ranged from 9.6% to 24.2% (Table 2). Both *Dodo* and *Viringe* mango varieties showed high percentage of reducing sugars. Mamiro et al. (2007) recorded a lower percent reducing sugars content of 3.59% for the *Dodo* mango of Morogoro. The reducing sugars content of the mangoes increased within the season and with days of storage-ripening. Thus late season fully ripened mangoes had the highest content of reducing sugars. *Viringe* mango had slightly higher reducing sugars than *Dodo* mangoes.

Total sugars

The total sugars content in the mangoes was from 10.5% to 32.4% (Table 2). Both *Dodo* and *Viringe* varieties showed higher percentage of total sugars especially during ripening. The total sugars content of the mangoes increased with days of storage-ripening making the most sugary fruits the fully ripened fruits. Such high percent total sugars were also observed in mangoes from Egypt (Zaied *et al*. 2007).

Total Soluble Solids (TSS)

The total soluble solids content in the mangoes was within 14.5% and 30.0% (Table 2). Both *Dodo* and *Viringe* varieties showed high percentage of total soluble solids especially during ripening. *Viringe* mangoes had higher total sugars than *Dodo* mangoes. Mamiro *et al*. (2007) also recorded a high percent total soluble solid content of 18.9% for the *Dodo* mango of Morogoro during room temperature

ripening. The total soluble solids content of the mangoes increased with days of room temperature storage-ripening. Late season fruits exhibited the highest total soluble solids content of the fruits.

Table 2: Percent reducing sugars, total sugars and soluble solids content of Dodo and *Viringe* mango (*Mangifera indica* L.) fruit of Eastern Tanzania

Storage time (days)	*Dodo* mango from Ifakara, Morogoro			*Dodo* mango from Muheza, Tanga			*Viringe* mango from Muheza, Tanga		
	SEASON			SEASON			SEASON		
	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late
Percent reducing sugars in mangoes									
0	12.3	13.1	14.1	9.6	10.7	11.8	13.4	13.8	15.4
2	13.8	14.5	14.8	10.1	11.2	13.0	13.6	14.4	16.7
4	14.4	15.4	15.8	10.5	12.3	13.9	14.0	15.1	17.7
6	15.0	16.3	20.3	10.9	13.4	15.1	14.5	15.6	18.5
8	15.8	19.1	24.2	11.6	14.5	16.6	15.2	16.5	19.4
Av. Dev.	± 0.4	± 0.3	± 0.5	± 0.3	± 0.3	± 0.5	± 0.3	± 0.3	± 0.4
Percent total sugars in mangoes									
Days	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**
0	14.7	15.8	17.1	10.5	12.2	13.4	17.3	18.6	21.3
2	15.5	16.9	19.2	11.0	12.7	15.0	18.2	19.5	22.4
4	16.5	18.7	22.3	11.7	14.0	16.1	19.0	20.5	23.5
6	17.9	20.5	25.7	12.3	15.3	17.4	19.6	21.1	25.0
8	18.4	23.3	32.4	13.0	16.5	18.7	20.5	22.0	26.7
Av. Dev.	± 0.4	± 0.3	± 0.4	± 0.3	± 0.4	± 0.5	± 0.3	± 0.3	± 0.5
Percent soluble solids in mangoes									
Days	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**	**Early**	**Mid**	**Late**
0	15.6	16.6	18.5	14.5	15.3	16.6	22.6	24.0	26.7
2	16.1	17.0	19.5	14.8	16.0	18.0	23.0	24.4	27.9
4	16.5	17.8	20.7	15.4	17.4	18.7	23.2	24.9	28.4
6	17.8	19.5	23.3	15.8	18.1	19.9	23.6	25.3	29.3
8	19.6	21.6	25.8	16.5	18.7	21.5	23.9	26.5	30.1
Av. Dev.	± 0.2	± 0.3	± 0.3	± 0.5	± 0.2	± 0.4	± 0.5	± 0.5	± 0.4

All data are the mean of five measurements ± standard error

Ash

The average ash content of the mangoes was 0.55 ± 0.06 g/100 g-fw (Table 3). *Viringe* mangoes had higher ash content (0.57 g/100 g-fw) than *Dodo* mango (0.52 g/100 g-fw). These levels are similar to values reported by Mamiro *et al*. (2007) for *Dodo* mango of Morogoro.

Crude fat and crude fibre

The average crude fat and crude fibre contents of the mangoes were 0.20 ± 0.13 g/100g-fw and 0.85 ± 0.06 g/100 g-fw, respectively (Table 3). The levels are lower than values for crude fat and crude fibre reported for *Dodo* mango of Morogoro by Mamiro *et al*. (2007). The low levels of crude fat in these fruits show that these fruits are not good sources of energy (Samson 1986). Crude fibre amounts of 0.90 g/100 g-fw have been reported by West *et al*. (1988) for commonly eaten East African fruits. Fibre helps to maintain the health of the gastrointestinal tract, but in excess it may bind trace elements, leading to deficiencies of iron and zinc in the body (Siddhuraju *et al.* 1996). Mamiro *et al*., (2007) measured a crude fibre content of up to 3.7% for *Dodo* mangoes from Morogoro, Tanzania. The crude fibre content exhibited a

slight decrease during the ripening process.

Table 3: Ash, crude fat, crude fibre, mineral elements and heavy metal contents in mango fruits

	Mango (*Mangifera indica* L.) fruits	
	***Dodo* from Ifakara, Morogoro**	***Viringe* from Muheza, Tanga**
	Attributes (g/100 g-fw)	
Ash	0.52 ± 0.05	0.57 ± 0.06
Crude fat	0.20 ± 0.13	0.22 ± 0.13
Crude fibre	0.85 ± 0.06	0.87 ± 0.06
	Minerals (mg/100 g-fw	
Potassium	219.34 ± 1.63	199.74 ± 2.12
Magnesium	41.10 ± 0.66	43.22 ± 0.11
Calcium	23.71 ± 1.03	20.56 ± 0.74
Sodium	2.93 ± 0.04	3.71 ± 0.05
	Heavy metals (mg/100 g-	
Copper	0.16 ± 0.04	0.21 ± 0.04-
Iron	1.27 ± 0.19	1.53 ± 0.14-
Zinc	0.31 ± 0.01	0.11 ± 0.03-
Manganese	1.19 ± 0.24	0.97 ± 0.16-
Aluminium	ND	ND
Lead	ND	ND
Cadmium	ND	ND

All data are the mean of five measurements ± standard error
ND – Not detected

Macro elements in fruits

The contents of mineral elements and metals in the fruits are summarized in Table 3. Potassium was the predominant element of the mineral elements examined in the fruits. The highest value of potassium (219.34-mg/100 g-fw) was found in the *Dodo* mangoes of Morogoro and the lowest value was 199.74 mg/100 g-fw found in *Viringe* mango from Muheza. The range of potassium content of the fruits herein reported were equivalent to the K values (150.0 – 280.0 mg/100 g-fw) of other fruits in East Africa (West et al., 1988) and of *Dodo* mango from Morogoro (192.76 – 198.64 mg/100 g-fw, Mamiro et al. 2007). Aremu and Udoessien (1990) reported similar potassium content (142 - 191 mg/100 g-fw) for orange fruits in Nigeria.

The amount of magnesium in the fruits ranged from 37.51 mg/100g-fw in *Dodo* mangoes from Muheza to 43.22 mg/100g-fw observed in *Viringe* mangoes. This range in Mg content was within the range (7.7 – 118.0 mg/100 g-fw) that was reported by Aremu and Udoessien (1990) for Nigerian oranges but was higher than the range (6 – 14 mg/100 mg-fw) reported by Hunt *et al*. (1991) and (7.7 – 22.3 mg/100 g-fw) reported Romero-Rodriguez *et al*. (1994) for Galician fruits. Mamiro et al. (2007) reported a lower magnesium content of 17.09 mg/100 g-fw for *Dodo* mangoes from Morogoro.

The calcium levels observed in the fruits ranged from 17.10 mg/100 g-fw in *Dodo* mangoes from Morogoro to 23.71 mg/100 g-fw in *Dodo* mangoes from Muheza (Table 3). *Viringe* mangoes had an average of

20.56 mg-Ca/100 g-fw. The calcium range was similar (16.0 – 28.0 mg/100 g-fw) to that reported by West et al. (1988) for some fruits in East Africa and within the range (7.4 - 55.1 mg/100 g-fw) reported by Aremu and Udoessien (1990) for some Nigerian fruits. The range was higher than the range (6.8 – 14.4 mg/100 g-fw) obtained for some fruits of Galicia (Romero-Rodriguez *et al*. 1994). Calcium in the mango fruits was lower than the FAO value (1.5 g/100 g).

Among the four mineral elements studied, sodium was the lowest in all the fruits. The amount ranged from 2.93 mg/100 g-fw observed in *Dodo* mangoes to 3.71 mg/100 g-fw in *Viringe* mangoes from Morogoro. The range of Na contents of fruits herein reported was comparable to the Na contents (2.0 – 4.0 mg/100 g-fw) reported for fruits in East Africa (West *et al*. 1988) but were low when compared to reports (2.7 – 8.9 mg/100 g-fw) of Na contents of some fruits of Galicia (Romero-Rodriguez *et al.* 1994) and (9.8 – 69.3 mg/100 g-fw of Nigeria (Aremu and Udoessien 1990). The sodium content measured was also lower than values (27.13 – 30.51 mg/100 g-fw) reported by FAO (0.29 g/100 g-fw) and by Mamiro *et al.* (2007).

Heavy metal contents in fruits

The heavy metals levels observed in the fruits are summarized in Table 3. The level of manganese obtained ranged from 0.97 mg/100 g-fw in *Viringe* mango to 1.19 mg/100 g-fw in *Dodo* mango. These levels were higher than those (0.021 – 0.574 mg/100 g-fw) reported by Hunt *et al*. (1991), 0.021 – 0.39 mg/100 g-fw reported by Ellen *et al*. (1990) and 0.08 – 0.2 mg/100 g-fw reported by Romero-Rodriguez *et al.* (1994) for passion fruits. The observed levels were lower than the ranges for the Recommended Daily Intake (RDI) of Mn of 2 - 5 mg/100 g-fw per day (Ellen *et al*. 1990).

The amount of copper in these fruits ranged from 0.16 mg/100 g-fw found in *Dodo* mangoes to 0.21 mg/100 g-fw found in *Viringe* mangoes. When the levels of Cu were compared to the permissible level of 4 mg/100 g for Cu in foods, all of these fruits had Cu amounts well below this level. The Cu contents were also lower (0.18 – 2.74 mg/100 g-fw) than that found in some Nigerian fruits (Aremu and Udoessien 1990) but higher than those (0.014 – 0.123 mg/100 g-fw) reported by Hunt et al. (1991). The contents were comparable to those (0.02 – 0.2 mg/100 g-fw) reported for Galicia (Romero-Rodriguez et al., 1994) for passion fruits. Ellen *et al*. (1990) reported a range of 0.034 - 0.23 mg/100 g-fw of Cu in some Netherlands fruits.

The levels of iron in the Tanzania mango fruits ranged from 1.27 to 1.53 mg/100 g-fw. The lower content was found in *Dodo* mangoes while the higher content was observed in *Viringe* mangoes. When compared to the levels of Fe (2.1 – 11.5 mg/100 g-fw) reported for some fruits of Nigeria (Aremu and Udoessien 1990), these Tanzania fruits seem to contain rather low amounts of iron. However, the range (0.07 - 0.37 mg/100 g-fw) of Fe levels reported by Hunt *et al*. (1991) and 0.3 – 0.6 mg/100 g-fw by Romero-Rodriguez *et al*. (1994) for Galicia were even lower.

The levels of zinc in the mango fruits ranged from 0.11 mg/100 g-fw observed in *Viringe* mangoes to 0.31 mg/100 g-fw in *Dodo* mangoes. Aremu and Udoessien (1990) reported a range of 0.89 - 46 mg/100 g-fw of Zn in some Nigerian fruits. When the Zn levels are compared to the permissible Zn level of 6 mg/100 g-fw in foods recommended by FAO and WHO, all mango fruits studied were below the permissible level. However, the levels of Zn in the Tanzania mango fruits were generally higher (0.002 – 0.06 mg/100 g-fw) than those reported by Hunt et al. (1991). but was within the range of 0.35 – 0.41 mg/100 g-fw reported by Ellen *et al*. (1990) for domestic fruits of Netherlands and 0.08 – 0.5 mg/100 g-fw reported by Romero-

Rodriguez *et al*. (1994) for Galician passion fruits.

Aluminium, cadmium and lead were not detected in the *Dodo* and *Viringe* mango fruits studied. However, Ellen *et al*. (1990) reported a range of 10 - 29 μg/kg of Pb and 2 - 9 μg/kg of Cd in some fruits from the Netherlands.

CONCLUSION

The physicochemical characteristics of off-vine, storage-ripened mango (*Mangifera indica* L.) fruits, *Dodo* and *Viringe* varieties, from Morogoro and Ifakara in Eastern Tanzania were determined. Values for proximate composition (ash, titratable acidity, crude fat, crude fibre, moisture), reducing and total sugars content, ascorbic acid content, total soluble solids content, concentration of four macro elements (Ca, Mg, K, Na) and seven heavy metals (Al, Cd, Cu, Fe, Mn, Pb, Zn) were measured. The mango fruits had high moisture content (>65%), moderate acidity (0.20 - 1.30% c.a.), low crude fat content (0.20 g/100 g-fw), low crude fibre content (0.85 g/100 g-fw), low ash content of 0.55 g/100 g-fw, high reducing sugars amounts (10.5 – 21.3%), high total sugars content (10.5 – 21.3%), high soluble solids content (14.2 – 26.5%) and high ascorbic acid content (15.8 – 25.1%). Potassium was the major macro element present (209.5 mg/100 g-fw). Heavy metal concentrations in the fruits were very low indicating insignificant pollution of the fruits. Moisture, reducing sugars, total sugars, and soluble solids content in the mango fruits increased within the season and with ripening storage. The ascorbic acid and titratable acidity content increased as the season progressed but decreased during the storage ripening period. Minimal seasonal changes were observed for ash, crude fat and crude fibre contents of the fruits.

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