Vol. 17(7) pp. 130-140, July 2023
DOI: 10.5897/AJFS2023.2253
Article Number: CEDC06470886
ISSN: 1996-0794

http://www.academicjournals.org/AJFS

African Journal of Food Science

Full Length Research Paper

Fruit consumption and storage practices among rural households in Chamwino district, Dodoma, Tanzania

Mwanaisha Assim Ngawembela[1]*, Akwilina Wendelin Mwanri[2] and Lucy Mlipano Chove[1]

[1]Department of Food Science and Bioprocess Engineering, School of Engineering and Technology, P. O. Box 3006, Chuo Kikuu, Morogoro, Tanzania.
[2]Department of Human Nutrition and Consumer Sciences, College of Agriculture, Sokoine University of Agriculture, P. O. Box 3006, Chuo Kikuu, Morogoro, Tanzania.

Received 3 March, 2023; Accepted 30 May, 2023

Fruit consumption is still a challenge in many parts of Africa, and hence micronutrient deficiency continues to be a serious problem in the continent. This study was conducted between December 2017 and May 2018 in Chinoje and Mzula villages in Chamwino district, Dodoma to assess availability of fruit, consumption, storage practices and nutrient content. People responsible for food preparation were interviewed from 345 randomly selected households by using semi-structured and food frequency questionnaires. Multiple logistic regression model was used to determine the relationship between frequency of fruit consumption and household socio-economic features by using SPSS. Laboratory analysis was conducted to determine nutrient content of baobab, which was the most consumed fruit. Analysis of Variance (ANOVA) was used to determine if significant variations existed in the nutritional quality of baobab fruit by using SAS. Only 35% of the households consumed fruit daily, while the majority consumed fruit from one to three days in a week. Monthly income, household size and headship significantly affected fruit consumption at $p<0.05$. Most of the baobab fruits were stored in polypropylene sacks (77.4%), followed by plastic buckets (3.3%) and others as shelled fruit (18.4%). Significant losses in Vitamin C and total carotenoids were observed in baobab fruits that were stored in sacks. Storage of baobab fruit in plastic bucket is recommended for quality maintenance of nutrients.

Key words: Fruit availability, consumption, micronutrients, food frequency, storage.

INTRODUCTION

Most of the developing countries face serious malnutrition problems. Vitamins and mineral deficiencies are high in Tanzania; whereby about 34 and 58% of children below five years are vitamin A and iron deficient, respectively (MoHCDGEC et al., 2016). Most rural diets are dominated by starchy and legume staples with little diversity leading to insufficient intake of micronutrients (Mbwana et al., 2016). More than 80% of people in low and middle income countries consume small amount of fruit that is below the WHO minimum recommended amount of 400 g

*Corresponding author. E-mail: mwassim.assim@gmail.com.

per day (Frank et al., 2019). Generally, Tanzania's fruit and vegetable consumption is lower than the recommended servings per day with higher consumption in urban compared to the rural consumers (Van der Maden et al., 2021).

Fruit is an important components of a healthy diet due to their low energy density, while rich in vitamins, minerals, fibres, and phytochemicals (Wallace et al., 2020; Del Río-Celestino and Font, 2020; Ahmed et al., 2022a). The burden of micronutrient deficiencies in the developing world particularly in populations with low intake of animal protein foods is intensified by low fruit intake (Frank et al., 2019). Evidence shows that fruit intake is associated with reduced risk for several non-communicable and chronic diseases (Yahia et al., 2017; Ahmed et al., 2022b). Approximately 2.7 million (2.8%) deaths per annum worldwide are linked to inadequate intake of fruit (WHO, 2022). The WHO ranks low fruit consumption as the sixth main risk factor for mortality in the world. Food consumption, especially fruit can be influenced by various factors including knowledge, attitude, social cultural factors, socio-economic factors, seasonal variation, level of production, processing and storage technologies (Amini et al., 2021; Basarir et al., 2022; Wallace et al., 2020).

Fruit are highly perishable, facing up to 50% postharvest losses in developing countries, particularly in Tanzania (Mujuka et al., 2020; Baltazari et al., 2020; Nadeem et al., 2022). Fruit storage is among the important post-harvest treatments towards reducing fruit losses thus improving their availability (Baltazari et al., 2020; Xylia et al., 2022; Al Shaibani et al., 2022).

Researches that have been conducted in Tanzania and other parts of the world, report about the nutritional and health importance of fruit and promote production and proper post-harvest handling so as to improve their availability (Van der Maden et al., 2021; Amao, 2018; Makule et al., 2022; Etefa et al., 2022). However, information on fruit consumption, rural household storage practices and the effectiveness in maintaining their nutritional quality is limited. Therefore, this study is aimed at assessing the frequency of fruit consumption, identifying storage practices and their effect on nutritional quality of fruits in rural Dodoma.

METHODOLOGY

Description of the study area

Chamwino is one of the six districts in Dodoma region. It is located in the central plateau of Tanzania extending between latitude 4° and 8° South and between 32° and 37° East. According to 2012 National Population Census, Chamwino district council has about 330 543 people of which 171 661 are females and 158 882 are males. The district has 5 divisions, 28 wards and 77 villages (Figure 1). The district has a dry savannah type of climate characterized by a long dry season starting late April to early December, and a short rain season starting from December to mid-April (Mutabazi, 2013; URT, 2013).

Study design and sampling procedure

The cross sectional study was conducted from December 2017 to May 2018. Multistage sampling techniques were used for the study whereby, two villages, Mzula and Chinoje from Chamwino district in Dodoma region, were randomly selected. Dodoma region was purposively selected because it is dominated by semi-arid climate which can affect fruit production and hence consumption. In addition, it is one of the regions with high prevalence of micronutrient deficiency such as iron deficiency (48%) (MoHCDGEC et al., 2016).

A sample of 172 and 173 households were selected from Chinoje and Mzula villages, respectively. Households were randomly selected with inclusion criteria of having a mother/caregiver who consented to participate in the study. Respondents were mothers/caregivers from the sampled households who were responsible for food preparation in the households.

Data collection

Interviewer administered questionnaire was used to collect demographic and socioeconomic information. Information about types of fruit available and consumed, factors influencing fruit consumption and storage practices were collected through face to face interview by using semi structured questionnaire. Data on frequency of fruit consumption was collected by using Food Frequency Questionnaire (FFQ).

Sampling of baobab fruit for laboratory analysis

Baobab fruits were the only sampled fruits for laboratory analysis since they were the most consumed fruits in both villages. Using completely randomized design (CRD) with $2 \times 3 \times 2$ factorial arrangement, sample size was determined by treatment combination and their replication. When two locations, three storage practices and four replicates were combined, 24 samples were obtained. The 24 samples were then multiplied into two storage times making a total of 48 samples for laboratory analysis. A total of 24 samples were collected at the beginning of the study, and the rest were collected after six months of storage. These samples were put in labelled polyethylene bags, packed in cool boxes and transported to Sokoine University of Agriculture (SUA) at the Department of Food Science and Agro-processing Laboratory for nutritional analysis.

Laboratory analysis

Fruit samples were analysed for moisture content, vitamin C and total carotenoid contents. Moisture content in the fruit samples was determined by oven drying method according to AOAC Method 934.01 (AOAC, 2007). Ascorbic acid was determined by using 2, 6-Dichloro-indophenol Titrimetric Method according to AOAC Method 967.22, 45.1.15 (AOAC, 2007). Total carotenoid was determined by spectrophotometric methods at 450 nm according to AOAC method 941.15 (45.1.03) (AOAC, 2007).

Ethical clearance and consideration

Ethical clearance was granted by the Ministry of Health, Community Development, Gender, Elderly and Children (MoHDEC) through the National Institute for Medical Research in Tanzania with reference number NIMR/HQ/R.8a/Vol. IX/2226. The permit and introduction letter was provided by the Sokoine University of Agriculture and respective region, district and villages authorities. Participants were

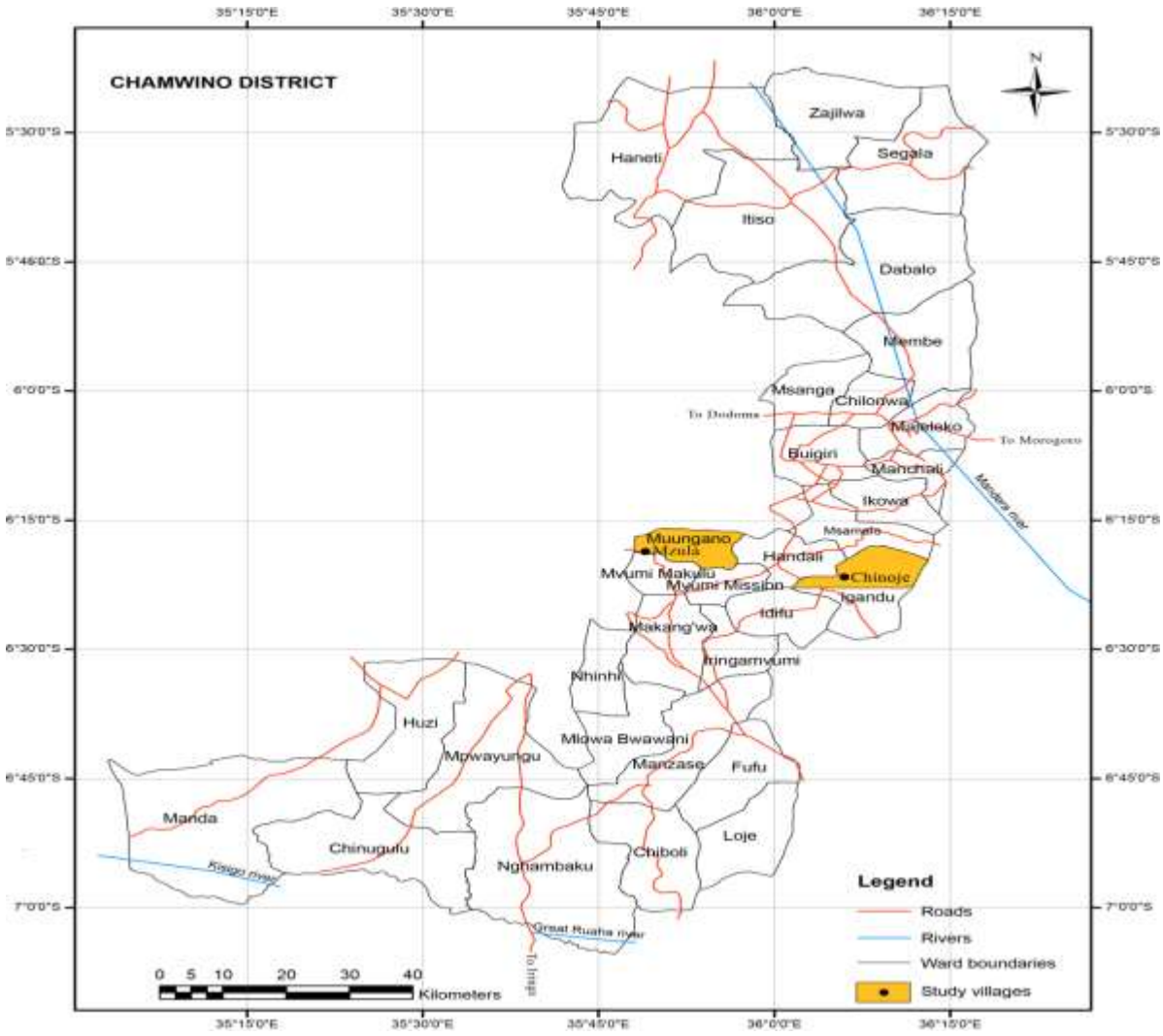

Figure 1. Map of Chamwino District showing the study areas.
Source: Mutabazi (2016).

provided with detailed information about the study and were requested to give their consent to participate in the study.

Data analysis

This was done by using Statistical Package for the Social Sciences (SPSS) software version 21. Descriptive statistics (frequency) was used for presenting the household socio-economic characteristics, levels of fruit consumption as well as fruit storage practices identified in the study area. Logistic regression model was applied to establish relationship between fruit consumption frequency and socio-economic factors. Daily fruit consumption was the dependent variable while household social, demographic and economic features were independent variables.

Laboratory data was analysed using Statistical Analysis System (SAS) version 9.2. Means and standard error were used to present nutritional quality of fruit. Analysis of Variance was done to determine the significant variations at ($p<0.05$) in the nutritional quality due to location, storage practice and time and their interaction effect. Means were separated by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Socio-economic and demographic characteristics of the respondents

About 65 and 10% of the respondents were monogamous and polygamous couples, respectively. Almost all respondents were farmers, 56.5% had primary education and 56.2% could read and write. Majority of households were male headed (Table 1). The average monthly household income was Tanzanian Shillings (TZS) 75000.

Availability of fruit

Both exotic and indigenous fruits were available in the study area. These included mangoes, oranges, pawpaw, watermelons, pineapples, bananas, baobab, *Grewia*

Table 1. Socio-economic and demographic characteristics of rural respondents in Chamwino District

Variable	Category	n	%
Status of the respondent	Mother	290	84.1
	Caregiver	55	15.9
Sex of the household head	Male	257	74.5
	Female	88	25.5
Marital status of mother or caregiver	Monogamous	223	64.7
	Polygamous	34	9.9
	Widowed	38	11
	Single	50	14.5
Literacy level of mother or caregiver	Not able to read and write	151	43.8
	Can read and write	194	56.2
Educational level of mother or caregiver	No formal education	141	40.9
	Adult education	8	2.3
	Primary school	195	56.5
	Post-secondary	1	0.3
Household size	1-3	25	7.2
	4-5	133	38.6
	>6	187	54.2
Main Source of income	Farmer	343	99.4
	Self employed	2	0.6
Monthly income (TZS)	Low income (< 200,000)	330	95.6%
	Low middle income (200,000 - 800,000)	15	4.4%

Source: Authors

Table 2. Source of fruits available in Mzula and Chinoje households.

Fruits	Own production		Purchase		Gift/food aid	
	n	%	n	%	n	%
Papaya	21	6.1	321	93	3	0.9
Watermelon	325	94.2	15	4.3	5	1.5
Oranges	0	0	345	100	0	0
Avocado	0	0	345	100	0	0
Grapes	1	0.3	344	99.7	0	0
Mangoes	9	2.6	333	96.5	3	0.9
Banana	0	0	345	100	0	0
Pineapples	0	0	345	100	0	0
Dates	0	0	345	100	0	0

Source: Authors

bicolor (donkey berries), *Grewia fallax* and *Grewia platyclada,* most of which were available on season. Most fruits were obtained through purchase, except for watermelon which was produced by more than 90% of the households (Table 2).

Fruits available in the study area did not differ from other parts of Tanzania (Aluko et al., 2016; Match Maker Associates, 2017; Tairo, 2021). Unlike other fruits, baobab fruits were available throughout the year and could also be stored for longer periods of time. Several other fruits were obtained through purchase in the village retail/periodic markets and also from vendors. Watermelons were produced by 94% of households in both villages, while a few households produced papaya

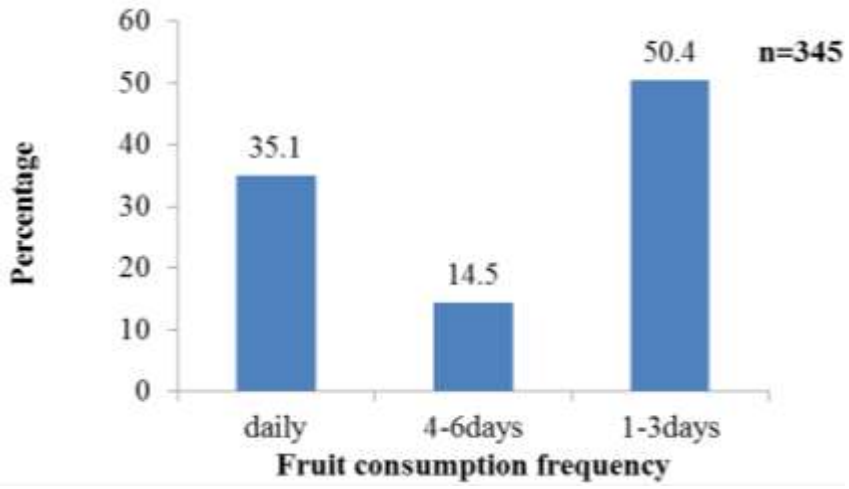

Figure 2. Weekly household fruit consumption.
Source: Authors

Table 3. Households fruit consumption by types and frequency (N = 345).

Fruit	Everyday in the week		4-6 days/week		2-3 days/week		Rarely		Never	
	n	%	n	%	n	%	n	%	n	%
Papaya	4	1.2	25	7.2	38	11	129	37.4	149	43.2
Oranges	9	2.6	34	9.9	28	8.1	124	35.9	150	43.5
Avocado	0	0	0	0	0	0	2	0.6	343	99.4
Grapes	0	0	0	0	0	0	4	1.2	341	98.8
Mangoes	12	3.5	2	0.6	57	16.5	194	56.2	80	23.2
Banana	9	2.6	11	3.2	61	17.7	113	32.8	151	43.8
Pineapples	0	0	0	0	0	0	29	8.4	316	91.6
Dates	0	0	0	0	0	0	1	0.3	344	99.7
Tamarind	0	0	0	0	0	0	33	9.6	312	90.4
Grewia bicolor (Mtafuta)	11	3.2	5	1.4	28	8.1	67	19.4	234	67.8
Grewia fallax (Ngwelu)	11	3.2	4	1.2	35	10.1	58	16.8	237	68.7
Grewia platyclada (Pelemehe)	10	2.9	16	4.6	36	10.4	111	32.2	172	49.9
Baobab	75	21.7	69	20	179	51.9	22	6.4	0	0

Source Authors

and mangoes. Low production of fruits in the villages could be attributed to households' preferences for satisfying basic energy needs instead of micronutrients. As a result more effort was put on production of starchy staples and legumes such as maize, millet, beans and peas. Limited knowledge and awareness regarding the role of fruits on alleviation of micronutrients deficiency could be the reason for low fruit production. These observations were also reported by other researchers (Mbwana et al*.,* 2016; Kissoly et al., 2018).

Consumption of fruit

Majority of the households consumed at least one fruit once (rarely) to about 2-3 days in a week while 35.1% consumed fruits daily (Figure 2). Daily consumption of some fruit such as baobab, bananas and mangoes was practiced by only 21.7, 2.6 and 3.5% households, respectively (Table 3).

Low daily consumption of mangoes, papaya, oranges, and bananas was due to low purchasing power. This has been reported in Tanzania and other parts of Africa (Kinabo et al., 2016; Msambichaka et al., 2018; Kabwama et al., 2019; Xaba and Dlamini, 2021). Baobab fruits were the most consumed fruits by all households in both villages. This is because they were available throughout the year, even during off season. Moreover, diversification into various products such as spices, sugar substitutes and/or flavours to dishes such as porridge

Table 4. Factors affecting fruit consumption.

Characteristics	n	%	Crude OR (95%CI)	*P*-Value	Adjusted OR* (95%CI)	*P*-Value
Monthly income	345	100	1.2 (1.11-1.57)	0.016	1.6 (1.19-2.92)	0.004
Household size	345	100	0.3 (0.20-0.76)	0.023	0.5 (0.37-0.63)	0.035
Education level						
Formal education	204	59.1	1.5 (0.32-2.86)	0.85	1.4 (0.2-2.87)	0.27
No formal education	141	40.9	0		0	0
Sex of HH						
Female	88	25.5	1.6 (1.30-2.52)	0.036	2.1 (1.66-4.96)	0.040
Male	257	74.5	0		0	0
Awareness						
Aware	322	93.3	1.2 (0.54-3.31)	0.56	1.1 (0.27-3.82)	0.864
Not aware	23	6.7	0		0	0

*Multivariate analysis of all the variables with backward exclusion.
Source: Authors

have all contributed to their increased consumption. This was also reported in Kilifi and Kitui counties in Kenya (Wanjeri et al., 2020). They are also used as medicine to relieve the symptoms of stomach upset. Medicinal uses of indigenous fruits by rural residents in Africa such as treatment of diarrhoea and skin diseases were reported by Maroyi (2019), Lisao et al. (2017) and Pfukwa et al. (2020).

Factors affecting fruit consumption

Table 4 shows factors affecting fruit consumption. Monthly income, household size and headship significantly influenced daily fruit consumption. Neither the education level of a mother or caregiver nor knowledge on the benefits of fruit to health had any significant influence on daily fruit consumption.

The income of consumers may determine and/or affect what they are able to purchase or consume. In the current study, an increase in household income significantly contributed to the increased fruit consumption. This suggests that, low income households allocate their budget to staple foods such as maize, sorghum and some pulses in order to fulfil their basic energy needs and to avoid hunger while higher income earners tend to have increased demand for other foods including fruits and vegetables. Studies in Tanzania and other African countries have reported on the significant positive influence of income status on increased fruit consumption (Mayen et al., 2016; Miller et al., 2016; Xaba and Dlamini, 2021).

Household size had a negative influence on daily fruit consumption. Daily intake of fruit decreased as household size increased. As stated previously, the priority of most poor households is to fulfil basic energy requirements. Fruits are not considered as a priority when resources are limited, especially where large families are involved. Similar findings reported by Plataroti (2016).

Daily fruit consumption increased more in female headed households than in the male headed households. This is an indication of difference in budget allocation to fruit between male and female headed households in the study area. These results are consistent with Asli (2020) and Plataroti (2016) who reported significant differences between male and female headed households with the later consuming more fruits than the former. These researchers stipulated that the quality of diets could be improved when females have full control over household resources.

Knowledge about fruit consumption did not show any significant impact on fruit consumption. Participation in nutrition training and awareness programs can contribute to new knowledge, leading to change in consumer behaviour. However, behavioural change is influenced several other factors including experience and culture. A study by Wagner et al. (2016) reported an improvement in the consumption frequency of antioxidant-rich fruits and vegetables among overweight and obese adults as a result of nutrition education. Nutritional education intervention was also reported to have improved fruits and vegetables preference among school children in West Texas, USA (Saha et al., 2020).

Education level of mothers/caregivers did not significantly influence fruit consumption in the households. The level of literacy may influence individuals to seek knowledge about healthy diets and lifestyles hence leading to increased consumption of healthier foods such as fruits. However, as previously stated, culture and experience play a significant role in behavioural change is irrespective of whether the individuals are educated

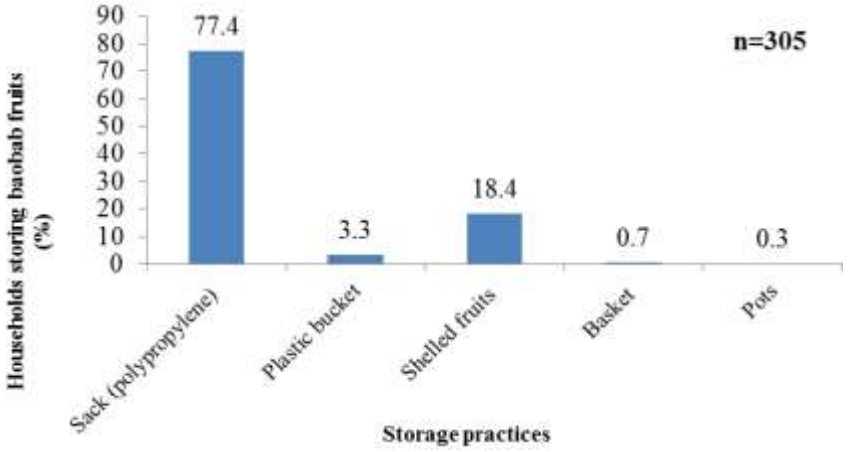

Figure 3. Baobab fruit storage practices in the village households.
Source: Authors

or not. These results are contrary to Msambichaka et al. (2018) who reported significantly higher fruit intake by educated people than the non-formally educated people in semi-urban Tanzania. A study by Kebede et al. (2022) in Addis Ababa Ethiopia, found that increased intake of plant foods including fruits was related to the education level of the mother/caregiver.

Baobab fruit storage practices

Baobab fruits were the most stored fruit in the households. They were stored in polypropylene sacks (Figure 3). Though the sacks were used for both shelled and un-shelled baobab fruits, it was more common for unshelled fruits. Storing of unshelled fruit allowed maximum use of the space in the sacks. A study by Eldoom et al. (2014) reported the use of polyethylene bags for storage of baobab fruit in Sudan. Normally, the shelled fruit were kept in polypropylene sacks and some were spread on the ground and roofs. Storage of fruit in their shells maintained colour and prevented fruit contamination by dust. Storage of shelled (whole) fruit has also been observed in other parts of East Africa (Wanjeri et al., 2020). Plastic containers were also used for storage of unshelled fruit. Baobab fruits and their products such as pulp powder were packed in plastic labelled containers for trading to be used as food (Darr et al., 2020). Baskets were normally used to keep shelled fruit whereas pots were used to keep unshelled fruit. The use of baskets and pots in baobab fruit storage has also been reported by Dandago et al. (2016).

Baobab fruit storage time

Baobab fruit were stored for about one week to ten months with the majority of households storing them for up to six months (Figure 4).

Quality deterioration observed during baobab fruit storage

Pests and insect infestation were the most important factors responsible for quality deterioration of baobab fruits during storage (Table 5).

Rats and termites were responsible for the observed infestation in baobab fruit both in the sacks as well as in shells. Poor strength of sacks and baobab shells provided easy entry and growth of pests and insects which could contaminate stored fruit by larvae, exuviae, and excreta (Vukajlović et al., 2018). Insect infested fruits lose their quality and appearance leading to their rejection (Adedeji et al., 2020). In some parts of Africa and Asia pest infestation of stored and non-stored fruit was also reported (Ansari et al., 2019; Nnzeru et al., 2021).

The colour of baobab fruit changed from pale yellow, to white and finally to red which was not acceptable by some consumers. There was no significant change in colour of baobab milk nectar stored from 1 to 30 days under different conditions (Chadare et al., 2017). Ndiaye et al. (2022) reported the stability of yellow colour after three months storage of baobab seed oil at temperature ranging from 20 to 45°C.

Mould growth was revealed by green and dark green colour of the unshelled fruits as reported by Patil and Kukade (2020) and Rawat (2015). Change of fruit colour to green and dark green which signified mould growth was not considered as a serious problem by respondents who considered it a normal colour change. This implies lack of awareness about the occurrence of moulds in stored fruit which are known to produce mycotoxins thus

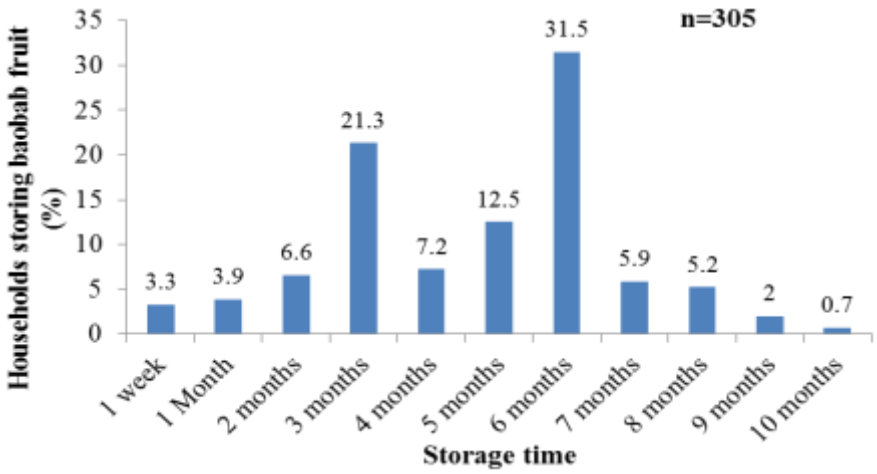

Figure 4. Storage time of baobab fruit in the village households.
Source: Authors

Table 5. Problems observed during baobab fruit storage.

Problem	n	%	Solution	n	%
Mould growth	22	18.6	Discarding fruits	7	7.5
Pests and Insect infestation	87	73.7	Putting sacks on platforms	40	43
			Changing sacks	15	16.1
			Discarding fruits	10	10.8
			Sorting out insects	21	22.6
Colour change	9	7.6	None		
Total	118	100		93	100

Source: Authors

endangering the health of consumers. The presence of moulds in baobab as well as other dried fruit has been reported (Abbas et al., 2019; James et al., 2022).

Effect of storage practice, location, and storage time on the nutritional quality of baobab fruit

Moisture content decreased in all samples after six months of storage. It was significantly lower in baobab fruit stored in plastic and shells. Regardless of the location, baobab fruit stored in sacks had the lowest vitamin C content whereby more than 50% was lost after six months of storage. Similarly, total carotenoid decreased significantly after six months of storage regardless of the storage practice and location ($p<0.05$) (Table 6).

After six months of storage, more than 30% of vitamin C was retained in the baobab fruits stored in plastic buckets and shells compared to those stored in sacks. This could be due to better barrier features of these materials against atmospheric oxygen which could oxidize the vitamin resulting in its loss. These findings are similar to those reported by Dandago et al. (2016) who reported maximum losses of vitamin C in unshelled fruit stored in baskets which exposed them to atmospheric oxygen.

There was more than 60% loss of carotenoid in stored samples for six months regardless of the storage practice. These losses could be due to instability nature of this vitamin which increased with storage time. A study done in Romania by Pop et al. (2016) reported 63% losses of carotenoids in dried apricots during storage in polythene bags for six months at room temperature. These results are in agreement with the current study.

Conclusions

Although several types of fruits were available in the study area, fruit consumption was generally low. About half of the households reported to have consumed fruit from one to three days a week. Fruit intake among households also depended on their socio-economic characteristics. Although education level of the mother

Table 6. Moisture (%), vitamin C (mg/100 g) and total carotenoids (µg/100 g) contents of Baobab fruit during harvesting and after 6 months of storage time*.

Storage location time	Moisture (%)	Vitamin C (mg/100 g)	Total carotenoid (µg/100 g)
MzulaSackTime1	11.22±0.49[a]	259.52±19.92[a]	3.35±0.75[a]
MzulaSackTime2	10.06±0.82[a]	66.17±30.81[d]	0.96±0.062[b]
MzulaShellTime1	9.78±0.47[a]	220.327±5.98[b]	2.97±0.684[a]
MzulaShellTime2	6.55±0.4[b]	72.09±13.383[d]	1.25±0.11[b]
MzulaPlasticTime1	10.61±0.64[a]	234.98±24.48[c]	3.02±0.684[a]
MzulaPlasticTime2	7.35±0.66[b]	120.74±18.91[ac]	1.08±0.044[b]
ChinojeSackTime1	10.71±0.15[a]	264.8±18.59[a]	3.01±0.52[a]
ChinojeSackTime2	9.35±1.46[a]	35.55±14.96[f]	0.92±0.101[b]
ChinojeShellTime1	9.73±0.13[a]	217.99±5.396[b]	3.67±0.52[a]
ChinojeShellTime2	6.62±0.75[b]	64.06±26.04[d]	1.24±0.172[b]
ChinojePlasticTime1	10.23±0.65[a]	240.73±14.96[c]	2.93±0.13[a]
ChinojePlasticTime2	7.01±0.02[b]	94.84±31.63[e]	1.123±0.04[b]

*Time 1 refers to harvesting time and time 2 refers to 6 months after harvesting. **Means with different superscript on the same column are significantly different following separation by Duncan's Multiple Range Test (DMR) at P<0.05.
Source: Authors

was not associated with increased fruit consumption, the female headed households consumed more fruits than the male headed households. In addition, households that had fewer members and higher income consumed significantly more fruits than the low income earners. Most households stored baobab fruit. Plastic containers were the best storage practises in maintaining the quality of baobab. In contrast, baobab fruits stored in sacks resulted in significant nutrient loss. There is a need to create awareness to consumers about the importance of fruit in the diet and also to promote home fruit gardens in order to increase fruit consumption. More research should be conducted to develop innovative and cost-effective technologies to prevent postharvest losses of fruit.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors are grateful to Scaling up Nutrition project (Scale N) for financial support of this study and Sokoine University of Agriculture for provision of laboratory space for analysis. Special thanks to the community of Chamwino, Dodoma for their participation in the study.

REFERENCES

Abbas M, Naz S, Shafique M, Jabeen N, Abbas S (2019). Fungal contamination in dried fruits and nuts: A possible source of mycosis and mycotoxicosis. Pakistan Journal of Botany 51(4):1523-1529.

Adedeji AA, Ekramirad N, Rady A, Hamidisepehr A, Donohue KD, Villanueva RT, Parrish CA Li M (2020). Non-destructive technologies for detecting insect infestation in fruits and vegetables under postharvest conditions: A critical review. Foods 9(7): 927.

Ahmed ZFR, Kaur N, Hassan FE (2022b). Ornamental Date Palm and Sidr Trees: Fruit Elements Composition and Concerns Regarding Consumption. International Journal of Fruit Science 22(1):17-34.

Ahmed ZFR, Kaur N, Maqsood S, Schmeda-Hirschmann, G (2022a). Preharvest applications of chitosan, salicylic acid, and calcium chloride have a synergistic effect on quality and storability of date palm fruit (*Phoenix dactylifera L*.). HortScience 57(3):422-430.

Al Shaibani FYY, Kaur N, Ahmed ZFR (2022). Reducing postharvest loss by improving fruit quality, shelf life, bioactive compounds of Rutab date (*Phoenix dactylifera L.* 'Barhi') using natural elicitors. Acta Horticulturae 1340:119-124

Aluko A, Kinyuru J, Chove LM, Kahenya P Owin L (2016). Nutritional Quality and Functional Properties of baobab (*Adansonia Digitata*) from Tanzania. Journal of Food Research 5(5):23-31.

Amao I (2018). Health benefits of fruits and vegetables: Review from Sub-Saharan Africa. In: *Vegetables-Importance of Quality Vegetables to Human Health*. (Edited by Asaduzzaman, M. and Asao, T.), BoD – Books on Demand, London, United Kingdom 53-33.

Amini M, Najafi F, Kazemi Karyani A, Pasdar Y, Samadi M, Moradinazar M (2021). Does socioeconomic status affect fruit and vegetable intake? Evidence from a cross-sectional analysis of the RaNCD Cohort. International Journal of Fruit Science 21(1):779-790.

Ansari MS, Basri R, Shekhawat SS (2019). Insect pests infestation during field and storage of fruits and vegetables. Health and Safety Aspects of Food Processing Technologies 121-207.

AOAC (2007). Official Methods of Analysis. (18th Edition). Association of Official Analytical Chemists International, Gaithersburg.

Asli K (2020). Sociodemographic factors as determinants of fruit and vegetable consumption in Malaysia. Jurnal Sains Kesihatan Malaysia 18(2):19-29.

Baltazari A, Mtui H, Chove L, Msogoya T, Kudra A, Tryphone G, Samwel J, Paliyath G, Sullivan A, Subramanian J Mwatawala M (2020). Evaluation of post-harvest losses and shelf life of fresh mango (*Mangifera indica L*.) in Eastern zone of Tanzania. International Journal of Fruit Science 20(4):855-870.

Basarir A, Al Mansouri NMN, Ahmed ZFR (2022). Householders attitude, preferences, and willingness to have home garden at time of pandemics. Horticulturae 8:56.

Chadare FJ, Madode YE, Tandji FBI, Egue FOM, Koffi M, D'Almeida ML, Fassinou TK, Affonfere M, Hounhouigan DJ (2017). Physico-

chemical, microbiological characteristics and storability of baobab milk nectar, a drink developed from the bottom of the pyramid in urban Benin. Bulletin de la Recherche Agronomique du Bénin (BRAB), Numéro spécial Technologie Alimentaire and Sécurité Alimentaire (TA&SA) 1-9

Dandago MA, Muktar MA, Igwe EC, Ndife J (2016). Proximate composition and effect of storage on ascorbic acid retention in Baobab (*Adonsonia digitata*) fruit pulp. International Journal of Basic Science and Technology 2(1):26-29.

Darr D, Chopi-Msadala C, Namakhwa CD, Meinhold K, Munthali C (2020). Processed baobab (*Adansonia digitata L*.) Food products in Malawi: From poor men's to premium-priced specialty food? Forests 11(6):1-14.

Del Río-Celestino M, Font R (2020). The health benefits of fruits and vegetables. Foods 9(3):369.

Eldoom AE, Ali EA, Abdel-Razig AK (2014). Baobab fruits (with/without Shell) affected by wrapping and type of packaging materials during storage period. Asian Journal of Medical and Pharmaceutical Researches 4(1):46-52.

Etefa OF, Forsido SF, Kebede MT (2022). Postharvest Loss, Causes, and Handling Practices of Fruits and Vegetables in Ethiopia: Scoping Review. Journal of Horticultural Research 30(1):1-10.

Frank SM, Webster J, McKenzie B, Geldsetzer P, Manne-Goehler J, Andall-Brereton G, Houehanou C, Houinato D, Gurung MS, Bicaba BW, McClure RW (2019). Consumption of fruits and vegetables among individuals 15 years and older in 28 low-and middle-income countries. The Journal of Nutrition 149(7):1252-1259.

James M, Owino W, Imathiu S (2022). Microbial contamination and occurrence of aflatoxins in processed baobab products in Kenya. International Journal of Food Science 2022.

Kabwama SN, Bahendeka SK Wesonga R, Mutungi G, Guwatudde D (2019). Low consumption of fruits and vegetables among adults in Uganda: findings from a countrywide cross-sectional survey. Archives of Public Health 77(1):1-4.

Kebede A, Jirström M, Worku A, Alemu K, Berhane HY, Turner C, Ekström EC, Berhane, Y (2022). Residential food environment, household wealth and maternal education association to preschoolers' consumption of plant-based vitamin A-rich foods: the EAT Addis survey in Addis Ababa. Nutrients 14(2):296.

Kinabo J, Mamiro P, Dawkins N, Bundala N, Mwanri A, Majili Z, Jumbe T, Kulwa K, Mamiro D, Amuri N, Ngowi M (2016). Food intake and dietary diversity of farming households in Morogoro Region, Tanzania. African Journal of Food, Agriculture, Nutrition and Development 16(4):11295-11309.

Kissoly L, Faße A, Grote U (2018). Implications of smallholder farm production diversity for household food consumption diversity: Insights From Diverse Agro-Ecological and Market Access Contexts In Rural Tanzania. Horticulturae 4(14):1-23.

Lisao K, Geldenhuys CJ, Chirwa PW (2017). Traditional uses and local perspectives on baobab (*Adansonia digitata*) population structure by selected ethnic groups in northern Namibia. South African journal of botany 113:449-456.

Makule E, Dimoso N, Tassou SA (2022). Precooling and Cold Storage Methods for Fruits and Vegetables in Sub-Saharan Africa. A review. Horticulturae 8(9):776.

Maroyi A (2019). Medicinal uses, biological and chemical properties of Wild Plum (*Harpephyllum caffrum*): An indigenous fruit plant of Southern Africa. Journal of Pharmacy and Nutritional Sciences 9:258-268.

Match Maker Associates (2017). Horticulture Study: Mapping of Production of Fruits and Vegetables in Tanzania Final Report. Match Maker Associates, United Kingdom.

Mayen AL, Bovet P, Marti-Soler H, Viswanathan B, Gedeon J, Paccaud F, Marques-Vidal P, Stringhini S (2016). Socioeconomic differences in dietary patterns in an East African Country: Evidence from the Republic of Seychelles. Public Library of Science One 11(5):0155617.

Mbwana HA, Kinabo J, Lambert C, Biesalsk HK (2016). Determinants of household dietary practices in rural Tanzania: Implications for nutrition interventions. Cogent Food and Agriculture 2(1):1-13.

Miller V, Yusuf S, Chow CK, Dehghan M, Corsi DJ, Lock K, Popkin B, Rangarajan S, Khatib R, Lear SA (2016). Availability, affordability, and consumption of fruits and vegetables in 18 countries across income levels: Findings from the Prospective Urban Rural Epidemiology study. The Lancet Global Health 4(10):695-703.

MoHCDGEC, MoH, NBS, OCGS, ICF (2016). Tanzania Demographic and Health Survey and Malaria Indicator Survey 2015-16. Ministry of Health, Community Development, Gender, Elderly and Children, Tanzania Mainland, Ministry of Health Zanzibar National Bureau of Statistics, Office of the Chief Government Statistician and ICF. Dar es Salaam, Tanzania, and Rockville, Maryland, USA. 630 p.

Msambichaka B, Eze IC, Abdul A, Abdulla S, Klatser P, Tanner M, Kaushik R, Geubbels E and Probst-Hensch N (2018). Insufficient fruit and vegetable intake in a low- and middle-income setting: A population-based survey in semi-urban Tanzania. Nutrients 10(222):1-16.

Mujuka E, Mburu J, Ogutu A, Ambuko J (2020). Returns to investment in postharvest loss reduction technologies among mango farmers in Embu County, Kenya. Food and Energy Security 9(1):195.

Mutabazi KD (2013). Identifying, Defining and Typologizing FVC and Upgrading Strategies (A Trans-SEC Document). Sokoine University of Agriculture, Morogoro.

Mutabazi KD (2016). Scaling-Up Nutrition: Implementing Potentials of nutrition-sensitive and diversified agriculture to increase food security.

Nadeem A, Ahmed ZFR, Hussain SB, Omar AE-DK, Amin M, Javed S, Ali A, Ullah S, Razzaq K, Rajwana IA, Nayab S, Ziogas V, Alam-Eldein SM, Mira AM (2022). On-tree fruit bagging and cold storage maintain the postharvest quality of mango fruit. Horticulturae 8:814.

Ndiaye EM, Faye PG, Sow A, Niane K, Ndiaye S, Baldé S, Cisse OIK, Ayessou NC, Cisse M (2022). Impact of Storage Conditions on the Physicochemical Characteristics of Baobab (*Adansonia digitata L*.) Seed Oil. Food and Nutrition Sciences 13(4):373-386.

Nnzeru LR, Tshikhudo PP, Mudereri BT, Moshobane MC (2021). Pest interceptions on imported fresh fruits into South Africa. International Journal of Tropical Insect Science 41(4):3075-3086.

Patil VS, Kukade PD (2020). Fungal spoilage of bakery products and its control measures. World Journal of Pharmaceutical and Medical Research 6(1):167-181.

Pfukwa TM, Chikwanha OC, Katiyatiya CL, Fawole OA, Manley M, Mapiye C (2020). Southern African indigenous fruits and their by-products: Prospects as food antioxidants. Journal of Functional Foods 75:104220.

Plataroti L (2016). What is the Impact of Gendered Headship on Food and Nutrition Security in the Breadbasket of Tanzania? An Investigation on Cross-sectional Data in Rural Tanzania. Masters Dissertation Wageningen University and Research.

Pop EA, Bunea A, Copaciu F, Socaciu C, Pintea A (2016). Stability of carotenoids in dried apricots (*Prunus Armeniaca L*.) during storage. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Food Science and Technology 73(2):93–98.

Rawat S (2015). Food Spoilage: Microorganisms and their prevention. Asian Journal of Plant Science and Research 5(4):47-56.

Saha S, Dawson J, Murimi M, Dodd S, Oldewage-Theron W (2020). Effects of a nutrition education intervention on fruit and vegetable consumption-related dietary behavioural factors among elementary school children. Health Education Journal 79(8):963-973.

Tairo VE (2021). Comparison of nutritional and anti-nutritional qualities of *Grewia forbesii* Hav. Ex Mast and *Grewia bicolor* juss fruits from Kitapilimwa Forest Reserve in Iringa District. Tanzania Journal of Science 47(4):1436-1441.

URT (2013). 2012 Population and housing census: Population distribution by administrative areas. National Bureau of Statistics, Ministry of finance. Dar-es-Salaam.

Van der Maden E, Ringo E, Likoko E (2021). Scoping study on fruits and vegetables: Results from Tanzania. Wageningen, Wageningen Economic Research.

Vukajlović F, Predojević D, Tanasković S, Miljković K, Gvozdenac S, Perišić V, Pešić S (2018). Susceptibility of dried berries to infestation by Plodia interpunctella (Lepidoptera: Pyralidae) in correlation with total sugar content. Julius-Kühn-Archiv (463):189-193.

Wagner MG, Rhee Y, Honrath K, Salafia EHB, Terbizan D (2016). Nutrition education effective in increasing fruit and vegetable consumption among overweight and obese adults. Appetite 100:94-101.

Wallace TC, Bailey RL, Blumberg JB, Burton-Freeman B, Chen CO, Crowe-White KM, Drewnowski A, Hooshmand S, Johnson E, Lewis R, Murray R (2020). Fruits, vegetables, and health: A comprehensive narrative, umbrella review of the science and recommendations for enhanced public policy to improve intake. Critical Reviews in Food Science and Nutrition 60(13):2174-2211.

Wanjeri N, Owino W, Kyallo F, Habte TY, Krawinkel MB (2020). Accessibility, availability and consumption of baobab during food emergencies in Kitui and Kilifi counties in Kenya. African Journal of Food, Agriculture, Nutrition and Development 20(5):16403-16419

World Health Organization (2022). Global burden of malnutrition [https://globalnutritionreport.org/resources/nutrition-profiles/] site visited on 11/02/2023.

Xaba T, Dlamini S (2021). Factors associated with consumption of fruits and vegetables amongst adults in the Alfred Duma Local Municipality, Ladysmith. South African Journal of Clinical Nutrition 34(2):72-83.

Xylia P, Chrysargyris A, Shahwar D, Ahmed ZF, Tzortzakis N (2022). Application of rosemary and eucalyptus essential oils on the preservation of cucumber fruit. Horticulturae 8(9):774.

Yahia EM, Maldonado Celis, ME and Svendsen M (2017). The contribution of fruit and vegetable consumption to human health. Fruit and Vegetable Phytochemicals: Chemistry and Human Health, 2nd Edition 1-52. Wiley-Blackwell, New Jersey, USA.