



Utilization and Challenges of Indigenous Methods of Mango Fruits Preservation by Farmers in Tivland

¹*Sambe, N., ²Ikwuba, A.A and ²Sugh, E.T.

1. Department of Sociology, University of Mkar, Mkar-Gboko, Benue State
2. Department of Sociology, Benue State University, Makurdi-Benue state

*E-mail Address: ngutors@gmail.com, : +23408058543839

ABSTRACT

The main goal of the study was to investigate the indigenous methods of preservation used in control of post-harvest losses of mango fruits by farmers in Tiv land; Specifically the study assessed the indigenous methods of preservation used in control of post-harvest losses of mango fruits by farmers; investigated how the methods are used in control of post-harvest losses of mango fruits and identify the problems associated with use of indigenous methods of preservation in control of post-harvest losses of mango fruits and determine ways of improving indigenous methods of preservation for control of post-harvest losses of mango fruits. The study adopted cross-sectional survey design while 400 respondents were selected using cluster sampling technique. Furthermore, Interview and Key Informant Interviews (KII) were used to collect data. For the interview, data analysis involved percentages while data collected through KII were analysed by transcription of responses key informants. Findings revealed that indigenous methods of post-harvest preservation of mango fruits in Tiv land included open air method, Pit method, Hot water method, hut method and potting method. Major problems of the indigenous methods include labour intensive nature, inadequacy of infrastructure, rodents or insects and birds; and shortage of preservation infrastructure. The study therefore recommends for Diffusion of potting method, provision of storage infrastructure to ensure that spaces are available for preservation of mangoes and provision of credit facilities to mango farmers so as to ensure that materials needed for postharvest preservation are available.

Keywords: Post-harvest losses, Mango fruits, Tiv land, Preservation methods, Mango farmers

Introduction

Mango is one of the tree crops that produce fruits for consumption and are produced in all parts of the world; however, tropics and subtropics are the main producers of the fruits. The fruits are also one of the most important fruit trees in these regions. It is grown in commercial quantities in more than 90 countries worldwide and is consumed both in fresh and processed form (Sauco 2004; FAO, 2007). Worldwide production of mango fruits is estimated at 38.95 million tonnes with over one hundred varieties (Bally *et al.*, 2009; FAO 2011; FAOSTAT 2012). Among the continents, Asia accounts for approximately 77% of global production, while America and Africa account for approximately 13% and 9% respectively (FAOSTAT, 2007). With Asian continent being the highest producers, India is the main global producer with 13 million to 17 million. In America, Mexico (1.5 million MT) and Brazil (1.2 million MT) are one of the highest producers. The main three African mango producing countries are Nigeria (795,000MT), Kenya (636,585MT) and Egypt (598,084MT) (FAOSTAT, 2012; Ravani and Joshi, 2013).

Commercial cultivation of mango fruits also appears to be lucrative enterprise in both domestic and international trade as the fruits have been on a significant and consistent demand in the international market (Galán Saúco, 2004; Iyango, Ugese and Swem 2012). It occupies the fifth place on total fruit crop production and consumption globally (Tharanathan *et al.*, 2006), accounting for over one-third of the worldwide production and consumption of tropical fruits

(Maneepun and Yunchalad, 2004). Large markets for fresh mango fruits are the Europe, North-America and Asia. The major countries which are leading exporters of fresh mango fruits in the world are United States, followed by Mexico, Pakistan and the Philippines respectively (Saúco 2004; Evans *et al.*, 2017). The most popular varieties in which are of high demand in the international market includes Kent, Tommy Atkins, Haden, Keitt and Julie (Spore, 2009; Evans, 2009). Alphonso' mango is also considered as one of the best rated mango varieties in the world, and some other varieties such as Ataulfo from Mexico attracting high demand in the market (Arauz, 2000).

Mango fruits have immense health and economic importance. The fruits are good sources of important minerals and vitamins the body needs and dietary substances that prevent harmful reaction of chemicals in the body (Talcott *et al.*, 2005). Minerals such as calcium, iron, magnesium, sodium, phosphorus, zinc and copper are found in mango fruits while vitamins like vitamin A (beta Carotene), B, C (ascorbic acid), vitamin E, fructose, glucose and sucrose are highly concentrated in the fruits. Mango fruits also contain water, carbohydrates, protein, fats, chetry fibre that is necessary for maintenance of health (FAO 2000; Bally 2006). The fruit is recommended to be included in the daily diet due to its health benefits such as reduced risk of cardiac disease, anti-cancer, and anti- viral activities (Sivakumar *et al.*, 2011). The fruit pulp which makes up 60-75% of fresh fruit weight contains 15% sugars, high amounts of vitamin A and some quantities of vitamins B and C (Samson, 1980).

The huge economic importance of the fruits is found in the tendency for mango fruits to be sold in both fresh and processed form. The fruits are important source of income for farmers who cultivate the fruits and entrepreneurs who process them. The fruits can be processed into several other by-products, including juices, nectars, and purees. Mango fruits can be processed into various products: unripe mangoes are normally processed into pickles, preserves, dessert or chutneys, while the ripe mango fruits can be processed into dried mango chips, mango wine, mango juice, mango concentrate, mango jam, mango jelly, mango syrup and canned mango (Ploetz *et al.*, 1994; Ugeese *et al.*, 2012).

Despite the high nutritive and economic value the fruits have to both farmers and the economy of Benue state, mango fruits are highly perishable and prone to high post-harvest losses (Yahia 1998; Nyishir, 2004;). This is due to the fact that the fruit possesses a very short shelf life and highly reactive to weather and vulnerable to decay, mechanical injuries and fungi infections (Sivakumar *et al.*, 2011). More importantly, mango fruits are seasonal, producing only once yearly. As a result of the seasonality, mango fruits supply during the period of high season is always above demand which leads to low prices and high post-harvest losses (Ambuko, 2016; Maloba *et al.*, 2017).

In developing countries such as Nigeria, post-harvest preservation of fruits such as mangoes generally involves utilization of indigenous methods (Horsthemke, 2004). Indigenous methods may be as old as the society itself and may be expressed in the form of ideas, skills, craft, techniques, and technologies (Flora 1992; Semali and Kincheloe, 1993) and are generally passed from one generation to another or from one person to another (Waren, 1987). Indigenous methods of post-harvest preservation have evolved through trial and error and proved flexible enough to cope with change. This trial and error practices when confirmed, become sustainable and indispensable methods to be utilised in agricultural endeavours (Rajasekaran, 1993; Kolawole 2001;).

Studies on indigenous methods of post-harvest preservation of mango fruits are conducted in Nigeria and other parts of the world. For instance, Abu-Goukh and Mohamed (2004), study

investigated effect of various traditional harvesting techniques on storability of mango fruits and found that each of the methods have profound influence on quality and shelf life of mango fruits. Weor (2007) investigated some of the different harvesting methods and storage life mango varieties stored hut in Gboko Local government Area. Baul, *et al.* (2015), study examined only the indigenous drying techniques used processing and preservation of mango fruits by Khonda tribes in India and ignored preservation of fresh mangoes.

The study therefore could be a pioneering investigation into the indigenous methods of post-harvest preservation of mango fruits in Tivland which produces significant proportion of the fruits with different varieties. The study therefore intends to fill two knowledge vacuums. The first gap is found in the investigation of indigenous methods of post-harvest preservation of mango fruits which appear to be neglected by researchers; the second gap bothers on area of study itself which produces mangoes in commercial quantities, yet no empirical investigations have been carried out to determine what indigenous methods farmers use to preserve the fruits in the area.

The objectives of the study include:

- i. To find out the indigenous methods being used to control post-harvest losses of mango fruits among farmers in Tiv land of Benue state.
- ii. To investigate how these methods are used by farmers in the study area
- iii. To know the problems associated with the use of indigenous methods of controlling postharvest losses in the study area.

Methodology

This study adopted a cross sectional survey design. The cross sectional survey design was chosen because it enabled the researcher to select samples from large population and also use statistics in the analysis.

The study area is Tiv land of Benue state. The ethnic group has a projected population of about 4,293,300 people based on annual average growth of 0.3 (NBS 2017; Our Collective Vision 2015). Tiv farmers cultivate mango fruits in commercial quantities. In recent times, plethoras of varieties of mango fruits are produced in the area. Some of the mango varieties produced in the state includes Local mango, which is one of the most produced varieties, Hindi, Julie, Peter, Ma Broken, Dubsha, John Bull, John Peter, Zill, John and Angbira. There is also evidence of production of most popular varieties in the international market such as Kent, Tommy Atkins, Haden and Keiths in the area (Nyishir and Ajayi, 2006).

The population of the study consisted of adult male and female who are mango fruit farmers in Benue state. The population of mango farmers in the study area, based on data generated by the researcher directly from mango farmers associations, is two thousand one hundred and forty four (2144).

Cluster sampling technique was used for selection of 400 respondents in the study area. Sampling process first involved purposeful selection of one local government area in each of the two geopolitical zones (Zone A and B) in Benue state. In zone A, Kwande and Ushongo Local Government Areas were selected while in Zone B, Gboko and Buruku Local Governments Areas were selected respectively. The local government areas were selected because they are local government areas where large quantities and different varieties of mango fruits are produced in the state (Our Collective Vision, 2015). In Kwande and Gboko Local Government Areas, 113 respondents were selected while 58 and 75 respondents were selected in Ushongo and Buruku respectively. In the process of sampling, the researcher went to each of the selected council wards (clusters) and obtained list of mango farmers associations from the officials. After the acquiring

the list, the researcher systematically selected mango farmers on the list whose names were within the first even numbers required in each of the council wards. Purposive sampling as in-depth interview was used to key informants. In each of the council wards in the selected Local Government Areas, 4 key informants were selected who were male and female mango farmers in the study. The selection process involved researcher identifying the women and male leaders of fruits farmers associations or groups through his rapport with people in the council wards..

The Interview method was used to collect data. In the process of data collection, the researcher recruited and trained two research assistants who assisted him in the distribution of the interview forms. After the completion of the training, the researcher and his assistants started administering the Interviews. In each council ward, the researcher and his assistants distributed the interviews for a maximum of twenty one (21) days. Respondents were required to respond to the questions asked by the researcher and his assistant and their responses written down in the questionnaire form. The Interviews were conducted through face to face contact with respondents as the researcher and his assistants physically moved to the locations.

Key Informant interview also was held with leaders of mango farmers associations in each of the selected council wards. The processes involved the researcher visiting the informants on the scheduled time to conduct the interview. The language used in the interview was Tiv. Data gathering involved use of tape recorders, phones and note books and pen to capture the interviews. For the data gathered through Interview, descriptive was adopted for data analysis while data gathered through Key Informant interviews was analysed through transcription of responses of the key informants.

Results and Discussions

This section presented data based on 386 instead of 400 samples that was statistically determined. This is because some respondents selected were not disposed to answering the questions.

Table 1 showed that, majority of the respondents fall within the age range of 30-39 with frequency of 24.9% (96), while those in the range of 20-29 were the least with percentage of 14.5% (56). Furthermore, 21.8% (84) of the respondents fall in the age range from 40-49 and 50-59 of them were numbered 18.4% (71), while 20.5% (79) respondents were 60 years and above. A critical look at the age categories showed that the proportion of respondents from age of 40 and above were considerably more than those between 20 and 39 years. Going by the National Youth Development Policy in Nigeria, which defined youth as all persons of ages of 15-35 years (Ega, 2004), suggested that youth, who have repository labour power, are not actively involved in mango farming in the study area. This finding might be consistent with several studies and assertions by government that youth involvement in agriculture is minimal as they do not find it attractive (Jibowo, 1998; Ekong, 2003; Adedoyin, 2005; Adewale *et al.*, 2005, Akinwumi, 2012).

With regards to sex distribution of the respondents, males were found to be slightly the majority with frequency of 51.6% (199), while females were 48.4% (187), constituting the minority in the study. Though male population seemed to be higher than that of the females, the difference is just 3.2% which is relatively small. These findings seemed to agree with study by Ugese *at al.* (2012), which showed higher proportion of males involved in mango production than females in Gboko Local Government Area. The finding also agreed with Olakoja (2017) and Gunlela and Mukhtar (2009) study showed that the overall proportion of females involved in agriculture is higher than that of the males in Nigeria but males are involved in production of certain crops than the females. Females were found to be involved more in production of such as yams, cassava, tomatoes and rice, while the males were found to produce more of tree crops such as mangoes, oranges and

cashew. This gap appeared to be related to land tenure system practiced in Nigeria which allows only males to inherit and own land (Ega, 1998). Thus, males could plant crops that take many years to start producing fruits while females produce more of annual crops as females do not own land, they probably do not want to cultivate crops such as mangoes that take years before maturing.

Table 1: Socio-demographic Characteristics of Respondents

Category	Frequency	Percentage
Age		
20-29	56	14.5
30-39	96	24.9
40-49	84	21.8
50-59	71	18.4
60+	79	20.5
Total	386	100
Sex		
Male	199	51.6
Female	187	48.4
Total	386	100
Marital status		
Single	107	27.7
Married	216	56.0
Divorced	48	12.4
Widowed	15	3.9
Total	386	100
Educational Qualification		
Uneducated	84	21.8
FSLC	75	19.4
SSCE	135	35.0
Diploma/NCE	76	19.7
Degree	16	4.1
Total	386	100

Source: Field survey (2019)

On marital status, married respondents constituted the bulk of the study with 56.0% (216), while widowed respondents had the least with 3.9% (15). Still respondents who were single had second highest with 27.7% (107) and divorced respondents came third with 12.4% (48). This corroborated a study by Ugese *et al.* (2012), also found that married people were more engaged in mango production in Gboko than people with other marital statuses. This could have implication on post-harvest preservation as married people are likely to have children and spouses that could help them during preservation work and thus lessen the burden of indigenous methods which is usually rigorous.

Data on educational qualification revealed that respondents with SSCE (secondary education) had most with 35.0% (135), while those with bachelor's degree or Higher National Diploma (HND) had 4.1% (16). Further, respondents with no formal education had second highest with 21.8%

(84), those with diploma or NCE and their equivalent came third with 19.7% (76) respondents, while those with primary education or their equivalents (FSLC) had 19.4% (75).

The predominance of respondents who are uneducated, First School Leaving Certificate (FSLC) and Senior School Certificate Examination (SSCE) suggested that most mango farmers in Tiv land were uneducated or had elementary education. This characteristic of farmers was not new as plethora of studies such as HSRC (2005); Mella *et al.*, (2007) and Dauda (2013) have shown that farming in developing countries such as Nigeria was predominantly undertaken by people with low educational background.

Table 2: Indigenous Methods of Post-harvest Preservation of Mango Fruits in Tiv land

Preservation Methods	Frequency	Percentage
Open air preservation	271	70.2
Pit preservation	48	12.4
Hot water preservation	35	9.1
Hut Preservation	32	8.3
Total	386	100

Source: Field survey (2019)

Table 2 had shown that most 70.2% (271) of the farmers preserved mango fruits by the use of “open air method”. This was followed by 12.4% (48) of the farmers who used “pit method” and 9.1% (35) of them used “hot water method”. Lastly, 8.3% (32) of the farmers were found to have used “hut preservation method”

The data revealed that open air preservation method had been used more frequently by farmers than the other methods. This suggested that the method is easier to use as it requires less physical labour from the farmers compared to other methods appear to be physically demanding and economically costly. The study observed that more farmers used indigenous methods which appeared to be relatively cheaper and rudimentary. This could be based on poverty level and low educational background. This seems to make the methods more compatible and easily accessible to the farmers (Ega, 1988).

Key informant interviews also identified other methods that were identified also by interview such as open air, hot water, pit and hut methods but added application of ashes and potting. A key informant noted that:

Another Key Informant also said:

“...mangoes were preserved first harvesting the fruits in mature but unripe form and preserved. Then ashes is applied and stored in clay pots...but generally we use open air system where the fruits harvested in mature but ripe state and placed in open space where there is free flow of air...”
(A male key informant from Mbatirkyaa council ward in Ushongo Local Government Area)

In an interview explained how the methods are utilized, a key informant noted:

“...in preserving mangoes we first took note of how the fruits were harvested...if they were not harvested in the right way and they hit on the ground, they’ll begin to spoil immediately...they will become soft at the place they’ve been hit...so we normally start preserving by using a long stick or iron hooked with a scissors like material and fitted with a sack. This is to ensure that the plucked fruits fall inside the sack and not on the ground...the fruits were harvested when they were semi ripe (kaegh)...we normally do this because some fruits get spoilt when they are fully ripe

while others develop bumps when they were fully mature, like Peter and Julie varieties... After this the mangoes were washed especially Julie (except varieties like Local mango, Peter and Hindi), kept in a cool place, then poured in sacks that were placed in a basket with the mouth open...also after washing the mangoes were placed in an open airy space..." (A Female Key informant from Yandev I Council ward in Gboko Local Government Area)

A key informant in Usar Council Ward in Kwande Local Government Area still argued that: "...We start by harvesting the mangoes that *kaegh*. This is because if you don't do this, you will lose more mangoes...you take mangoes to market to sell, when you come back you find plenty over ripe mangoes fallen on the ground, decaying...so from what I know and do, mangoes are preserved by *hile* (incubation). This happens in three ways...first way is to harvest the mangoes when they are not fully ripe...pour hot water on them, kept them under the sun for some hours and they take them and keep in a cool place...the hot water prolong shelf life of the mango which to other people's eyes will appear ripe but it is not and can stay for a long time...the second way is to bury the mangoes on the ground...the quality of mangoes under this process were more than that of the first method...third way was to harvest the mangoes and keep them under shade and cover with grass...in this way only mangoes that are on the ground will ripe and allows a person to come select the mature ones, eat or sell till the mangoes are exhausted..." (A Key Informant in Usar council ward, Kwande Local Government Area)

The indigenous methods of preservation used by farmers in Tivland also seemed to hinge on the principle of incubation (*hilen*), which involves harvesting the fruits in mature but unripe state with good harvesting technique as this is also aimed at increasing the shelf life of mangoes during preservation. Indigenous methods seem to be controlling ripening process of the fruits on a pace predetermined by farmers. The practices also prevented the fruits from developing bumps or attacked by bats, wasp or insects when fully matured on the tree. After this process, fruits are washed (or not washed) depending on the variety and are stored in pits, hut, applied hot water or applied ashes and stored in baskets. This method controls the amount of heat the mangoes were exposed in order to inhibit softening and subsequent decaying. It prevented also attacks from insects and rodents.

These findings have been corroborated by some studies. Lakshminarayana *et al.*, (1970) study which showed that mangoes were preserved by plucking them at mature but unripe stage before preservation. This is also consistent with studies by Akurugu *et al.* (2016), which found that farmers preserved mango fruits by keeping them in a cool open aired environment after harvesting. A study by Weor (2007), also found that local farmers preserved mango fruits in huts. The process involved harvesting the fruits at semi ripe stage and heaping them on the floor in a hut. Korir *et al.* (2014), study also saw similar findings. The study found that local farmers preserved mango fruits in barns which were similar to huts. The process involved harvesting the mango fruits in mature but unripe forms and keeping them in barns constructed with local wood and bushes. Furthermore, Agyapong (2013), studies in Ghana also revealed that farmers preserved mangoes by exposing them to cold air. The process involved harvesting of the fruits using harvesting aid and heaping the fruits in a place where the fruits were exposed to enough air. Aboagye (2009), study also proved that mangoes were preserved in airy environment. The study confirmed also that the process of preservation involved harvesting of the fruits by the farmers using harvesting sticks and keeping them in a cool place to be exposed to air.

Table 3: Problems of Indigenous Methods of Post-harvest Preservation of Mango Fruits

Problems	Frequency	Percentage
Inadequate Space	86	22.3
Physically demanding	118	30.6
Time consuming	47	12.2
Cost of materials	21	5.4
Shrink	48	12.4
Spoils baskets	12	3.1
Don't last long	23	6.0
Subject to attack by rat/insects	26	6.7
Thieves	5	1.3
Total	386	100

Source: Field survey (2019)

Table 3 presented problems inherent in the use of indigenous methods of mango fruits preservation in Tiv land. The table has indicated that most respondents listed physically demanding nature of the methods with 30.6% (118). This was followed by respondents who identified inadequacy of space needed to keep the mango fruits with 22.3% (86). Next was group of respondents who felt the methods made the fruits shrink with 12.4% (48) followed by those who thought the methods were time consuming with 12.2% (47) of the respondents. Others still said, the methods sometimes made the fruits vulnerable to attack by rats or insects when spread on the floor with 6.7% (26) respondents and those who attested to the economic cost of acquiring the preservation materials with 6.0% (23). Some of the respondents listed economic cost of acquiring the preservation materials with 5.4% (21) and those who felt the methods caused damage to baskets with 96.7% (23). Lastly, 1.3% (5) of the respondents said the methods make fruits susceptible to theft.

In an interview, a key informant reiterated:

“... indigenous methods of preservation...are too hectic, they takes most of our time...” apart from this you need big space to preserve mango fruits... most of us do not have the space...as a result we are unable to preserve all the fruits we have...buildings with open air are needed but we don't have...sometimes we use a small room for preservation which is not enough...” (A male key informant who hails from Mbaityough Council Ward in Buruku Local Government Area)

The above findings seemed to be consistent with studies conducted by researchers regarding the challenges of the use of indigenous methods. The findings however were not consistent with a study by Korir, *et al.* (2014), found that short storage period was one of the shortcomings of indigenous methods of post-harvest preservation. Similarly, a study by Akurugu, *et al.* (2016), found that storage methods used by farmers in Ghana had negative impact on the post-harvest quality of the mango fruits. The study pointed out that methods such as open air preservation, in which the fruits were kept in open field or on the farm, subjected the fruits to attack by insects, rodents and also exposed the fruits to too much sun light which affects the fruits adversely. A study by Korir *et al.* (2014), found that most of the farmers under study could not preserve mangoes in large quantities because they did not have barns and other infrastructures.

Conclusion

Based on the findings, the study concluded that indigenous methods of post-harvest preservation of mango fruits in Tiv land included open air method, pit method, hot water method hut preservation method and ashes method. The process started with harvesting the mangoes at their mature but unripe stage. This was because some varieties like Julie, Hindi and Peter got spoiled when they were allowed to fully mature on the tree as the fruits develop bumps, while other varieties were vulnerable to attacked by bats and wasps. After harvesting the mangoes using long pole fitted with scissors and adapted with bag, the fruits were kept on a cool place where there was enough air. Fruits such Julie and Peter were preserved under this method. This method prevented the fruits ripening at same time which often led to high losses.

The study also found that in open air method, mango fruits were also harvested semi ripe, washed and kept in a cool dry place, sprinkled with water often. Varieties such as Local Mango, Dausha, and Mummy were preserved in this way. In pit method mangoes were harvested, washed (or not) depending on the variety and kept in a pit under a tree to avoid heat. Hot water method involved harvesting the fruits, washed (or not), depending on the variety, dipped in hot water and kept in a cool place. Hut method involved harvesting of the fruits in semi ripe form and stored in hut. For ashes and potting method, mangoes were harvested in semi ripe form, washed, depending on the variety and ashes were robbed on the fruits and stored in clay pots.

Problems of the indigenous methods included physical demanding nature of the methods, inadequacy of space needed to preserve the mango fruits, while other problems noted included lack of capacity to prevent fruits from shrinking and time consuming nature, exposure of the fruits to attacks by rats or insects, perceived short term preservation and susceptibility to theft.

Recommendations

Based on the above conclusion, the following recommendations are made:

- i. Diffusion of potting method. This method seems to be used by only few farmers in Tiv land but more farmers need to be aware of this method. This should be the responsibility of extension workers.
- ii. Provision of storage infrastructure to ensure that spaces are available for preservation of mangoes. This responsibility should fall on government and Non-Governmental Organizations.
- iii. Provision of credit facilities to mango farmers so as to ensure that materials needed for postharvest preservation are available. This should be the responsibility of Non-Governmental Organizations and government.

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