Indigenous Preservation Practices and Shelf Life of Stored Yams in Benue State, Nigeria: Implication for Post-Harvest Management and Food Security

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ABSTRACT

Several empirical studies have been conducted on the relationship between indigenous practices and yam tuber preservation. However, there is a lack of empirical evidence regarding the extent of effectiveness of the existing indigenous preservation practices in reducing yam postharvest losses with regard to prolonging the shelf life, which underscores an existing gap in knowledge. The purpose of this study is to examine the extent of effectiveness of existing indigenous preservation practices in prolonging the shelf life of stored yam tubers in Benue State, Nigeria, using a cross-sectional survey design based on a proportional sampling technique involving 255 respondents. The result of the chi-square test shows the probability value of 0.000<0.05; hence, the study rejected the null hypothesis. A symmetric Phi value of 0.635 was obtained, showing a positive association between the variables. Thus, application of the existing indigenous yam preservation practices led to the overall improvement in the shelf life of stored yams by 34%. The study recommends that government and nongovernmental organizations should provide both financial and technical assistance to rural yam farming families, in the form of loan facilities. Yam farmers should also form cooperative societies in order to borrow more funds from financial institutions. This will boost the expansion of storehouses to accommodate the increasing quantity of yam tubers harvested, provide good ventilation in stores, and enhance free traffic during the removal of sprout development in storehouses to avert yam tuber postharvest losses and prolong the shelf life of the stored yam tubers in the study area.

KEYWORDS: *indigenous, preservation, practices, yam, shelf-life, Benue State.*

JEL CLASSIFICATION: *C31; M11; N57; O13; Q12*

1. INTRODUCTION

Indigenous practices exist across all societies around the world, and they create the basis for local-level decision-making in most sectors of most nations' economies; most nations of the world over the years have made use of their indigenous practices in transforming their economies. Globally, indigenous practices have become a subject of interest explored among academia, development partners, and nongovernmental organisations towards solving medical, agricultural and environmental challenges. It is the traditional knowledge developed

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through peoples' experiences in their local community via the process of managing the challenges of everyday life (Matsika, 2012).

In the domain of yam preservation, most indigenous practices seem archaic and primitive, but still prove to be reliable and effective. Most indigenous yam preservation practices often evolve through trial and error and have proven flexible enough and indispensable for yam tuber postharvest loss control (Pine, 2018). One of the ancient indigenous preservation practices worthy of mentioning in Africa is the use of wood ash, which has a long-standing history among the Bar-Sauri of Kenya, East Africa. This indigenous preservation practice of the use of sneeze wood ash for storing grains and tubers among farmers across the African continent is common. Sneeze wood (*Ptaeroxylonobliguum*) leaves and barks are burned, with the ashes acting as pest repellent on tubers. Similarly, the soot out of the burning sneeze wood also helps in warding off insects during storage of grains (Chirimuuta & Mapolisa, 2011).

Other indigenous preservation practices in Africa, although not fit for the preservation of yams, such as the practice of preserving agricultural produce on a wooden structure known as "*Msanja*" in Malawi, South-Eastern Africa continued to exist for generations. This platform is constructed above the fire to store harvested grains and all sorts of peas common among rural farmers. The structure helps protect crops, especially grains, from weevils and other pests. The soot coating makes them bitter and inedible by both pests and rodents. The structured wooden platform (*msanja*) made for preservation practices is a low-cost indigenous preservation technology (Kamwendo & Kamwendo, 2014).

Similarly, among the ethnic groups of Benue, Taraba, Plateau and Nasarawa States, North-Central Nigeria, the indigenous practice of preserving crops on a wooden structured platform, especially among the Tiv ethnic group of Benue State named "*Dzaar*" and "*Shasegh*" constructed above the fire for preservation of grains, similar to the "*Msanja*" platform used in Malawi, is common among rural farming families as a practice of preventing postharvest losses of grains. Other indigenous preservation practices common among most rural communities of Nigeria include the use of local pesticides such as mahogany plant, pepper, tobacco, and *neem* leaves, among others. These indigenous preservation practices helped most rural farming families prevent weevils from burrowing all kinds of grain and to reduce postharvest losses (Chirimuuta & Mapolisa, 2011).

Yam (*Discorea rotundata*), a staple crop, is one of the tuber crops produced from the agricultural sector of the Nigerian economy. Yam is produced for both subsistence and commercial purposes in Benue State, Nigeria. This crop is vital to the socioeconomic wellbeing of Benue inhabitants considering its subsistence and commercial value. However, yam farming families who cultivate this vital crop often witness setbacks occasioned by postharvest losses within April-June annually.

Although improvements in technologies such as chemicals and refrigerators for preservation exist and have greatly enhanced preservation, reduction of yam postharvest losses, and prolonged shelf life of stored yam tubers, these preservation practices have been viewed by professionals and academia to constitute health and environmental hazards due to emission of harmful substances that contribute to climate change, residues and toxins; hence agitation for reintroduction and adoption of indigenous preservation practices are adjudged to be free of toxins and residues. Preservation of harvested yams by rural yam farmers is cardinal to the yam production chain in rural areas. However, the practices of preserving yams are rudimentary and traditional in nature. In Benue State, the yam hub of Nigeria (Shambe, 2017), yam farmers employ traditional practices of preserving harvested yams such as wood ash, shrubs, and other known plant extracts to minimize incidences of yam postharvest losses. These indigenous preservation practices have existed for decades and have adjudged the status of cultural norms by yam farmers in the study area. Disturbing, however, is the surge in yam postharvest losses in Benue State, which often leads farmers to setbacks that call for urgent interventions.

In Africa in general and Nigeria in particular, empirical studies on indigenous preservation practices aimed at checking yam post-harvest losses exist and are properly explored, such as: Abubakar and Nasiru (2017), Abdullah and Hassan (2014), Iorzua et al. (2020), Okigbo (2004) and Shambe (2017) among others. Despite the foregoing, however, there is a dearth of empirical evidence on the effectiveness of existing indigenous preservation practices with regard to prolonging the shelf life of root tuber crops, especially yam. There is, therefore, a dire need to examine the extent of effectiveness of existing indigenous preservation practices in prolonging the shelf life of yam in Benue State, Nigeria. This study provides an answer to the following questions: to what extent are existing indigenous preservation practices effective in prolonging the shelf life of yam tubers in Benue State, Nigeria? It is equally anchored on the null hypothesis that the application of existing indigenous preservation practices is not effective in prolonging the shelf life of yam tubers in the study area. By exploring the extent of efficacy of application of traditional (indigenous) preservation methods on the shelf life of yam, particularly in the study area, this study has demonstrated its uniqueness, a sharp departure from the existing studies on the subject matter which focus on orthodox methods. Again, no study on the subject matter to the knowledge of the researchers is specifically directed to Benue State. This study has filled this empirical gap and contributed to the literature on postharvest management in among the developing economies. This study is expected to serve as a guide to farmers, agricultural scientists, policy makers, and the Benue State Government in terms of aiding the formulation of sound and relevant policies that would facilitate the attainment of food security, since yam is one of the major staple crops in the state. This would unleash the potential of the state to enhance the agricultural value chain. It is also expected to stimulate scholarly discourse on the subject matter and contribute to the existing debate about the effectiveness of the application of indigenous (alternative) practices to yam preservation in the study area.

1.1 Study Setting

The study was conducted in Benue State, Nigeria. Benue State occupies a land mass of 34,059 square meters with a population density of 183 per km2 square and a projected population of 6,588,848 at a 3% growth rate (NPC, 2020 projection). Compared to Lagos and Kano states, with over 15 million people each, Benue is generally considered to be one of the heavily populated states in Nigeria. Its geographical coordinates are longitude 7^0 47’ and 10^0 0’E, latitude 6^0 25’ and 8^0 8’ N. The state lies within the Savannah zone of the country, which stretches from longitude 4^0 E to 10.20 E and latitudes 6.50 N to 11.00N. The state is bounded by Nasarawa State in the north, Taraba in the East, Cross River in the South Eastern part, Enugu and Ebonyi to the South East and Kogi state to the Western part.

Benue State has 23 local government areas and three dominant ethnic groups: Tiv, Idoma, and Igede. The state is divided into three agricultural zones: the eastern agricultural zone, comprising Katsina-Ala, Konshisa, Kwande, Logo, Ukum, Ushongo, and Vandeikya. The Central agricultural zone comprised Buruku, Tarka, Gboko, Makurdi, Guma, Gwer-West, and

Gwer, while the Southern agricultural zone comprised Ado, Oju, Agatu, Okpokwu, Apa, Otukpo, Obi, Ushongo, Ogbadibo and Ohimini. Since all the tribes have an agrarian background, with yam being their major food crop, this portrays the tendency for the adoption of the traditional yam preservation methods in virtually all the ethnic groups in the state, though with slight variations. The vegetation of Benue State is typical of the southern Guinea savannah, characterised by sparse grasses and numerous species of scattered trees. Agriculture forms the main stay of the Benue State economy, engaging over 80% of the population (Benue State Development Plan (BSDP), 2016), and yam is one of the major root tuber crops produced in both commercial and subsistent quantities in the state, hence earning it the largest yam market in west Africa (Shambe, 2017). Yam holds substantial economic importance as a staple food, providing food security for millions in tropical regions. Their cultivation supports employment, livelihoods, and income generation for farmers, contributing to rural economies. Yams are a valuable cash crop, with international trade boosting export earnings for producing countries such as Nigeria and Ghana. Additionally, yams have industrial applications, such as starch utilization in the food and pharmaceutical industries. The economic significance extends to biodiversity conservation, environmental benefits, and cultural practices, making yams a multifaceted contributor to global and local economies. After the Introduction section, we have Section 2 which captures the brief empirical review, followed by Section 3 which describes the methodology of the study. Section 4 features the presentation and discussion of results, while Section 5 deals with Conclusions and Recommendations.

2. BRIEF EMPIRICAL REVIEW

There are limited empirical reviews on indigenous preservation practices and shelf life of stored yams. However, some studies have investigated the storage methods and shelf life of yams (Abubakar & Nasiru, 2017; FAO, 1998; Iorzua et al. 2020; Lancaster & Coursey, 1984; Maalekuu, et al. 2014; Mark 2017; Nkwain et al. 2020;). A study by FAO (1998) found that the maximum storage life of yams in the barn is six months, with losses reported to be 10% to 15% during the first three months and up to 30% to 50% after six months. Maalekuu et al. (2014) investigated the effect of three storage methods on the quality and shelf-life of white yam cultivars in Pona and Tela, and found that the majority of farmers estimated the storage life of yam to be 150 days (5 months). A review of traditional post-harvest technology for perishable tropical staples found that yams are normally stored in a fresh state, while only a very small percentage are processed. The storage life varies, but most yams are considered to be the least perishable among the major roots and tubers (Lancaster & Coursey, 1984). In a closely related study, Nkwain et al. (2020) investigated indigenous knowledge systems (IKs) pertaining to the preservation and storage of food crops, examining their integration with external methods to extend shelf life. The study focused on 11 of the 19 villages comprising the Lower Boyo Division in the Northwest Region of Cameroon. Employing a three-stage sampling approach involving purposive, random, and snowball techniques, the study arrived at a sample size of 180. The findings revealed the utilization of approximately 17 types of IKs, 7 external knowledge (EK), and 7 adaptive methods. Integration of IKs with EK successfully extended the shelf life of food crops, enabling the majority of farmers to store their produce for over ten months. The study establishes a crucial link between IK practices and external EK, showcasing their role in improving shelf-life extension in developing countries. The researchers recommend encouraging a participatory approach in integrating IKs with EK, particularly in rural areas facing challenges in accessing farming inputs and skills. But this study is not specifically about yam storage.

Nkwain et al. (2019) also assessed various food crop varieties and distinct IK strategies applied to post-harvest crops in nine out of the nineteen villages in the Belo Sub Division. Utilizing purposive, random, and snowball sampling techniques to achieve a sample size of 150, the study employed questionnaires, focus group discussions, interviews, and field observations for data collection. Results identified twenty-four types of IKs in food storage, with emphasis on preventing weevils, mould, rotting, and rodents and thus, utilizing the main preservation facility. Despite available IKs, farmers experienced significant losses (20 to 43%) due to limited space, storage facilities, and fuel wood. The study recommends integrating IKs with scientific post-harvest management knowledge, training, and providing integrated facilities in the study area.

Innovative ways to preserve harvested yam tubers to last for a year include curing, which involves allowing the yam tubers to dry after harvesting, and using appropriate pre-storage treatments against microbial decay and sprouting. Shelf-life can be extended up to 1 year at 12-15°C and 85-90% relative humidity, but cold storage facilities are not available to smallholder producers and traders due to cost (Sugri et al., 2017). Overall, while there is limited empirical research on Indigenous Preservation Practices and Shelf Life of Stored Yams, traditional storage methods and appropriate pre-storage treatments can help extend the shelf life of yams. The reviewed studies focus on other climes. To the knowledge of the researchers, no study has been specifically directed at the subject matter of Benue State. This is the obvious gap that this study has filled.

3. METHODOLOGY

This study used the survey design to obtain and analyse data. Non-parametrtic methods of data analysis were utilised, given the qualitative nature of the data involved. Thus, cross-sectional data were obtained from the selected farmers only at the time of the research (June 2023). For the purpose of this paper, data were collected from primary sources through structured interviews, key informant interviews and focused group discussions. Thus, a total of 12 informants were interviewed to elicit qualitative data for analysis of the phenomenon of study. The key informant interviews were conducted at the premises of every interviewee in each council ward. These interviews were recorded using tape recorder and a Vivo smart phone which were later translated by the researchers. The rationale behind selecting this particular instrument was to guarantee that any misunderstandings pertaining to the phenomenon under investigation through the use of a structured interview tool would be cleared up by individuals with expertise in the difficulties of applying traditional preservation techniques in relation to postharvest losses of yams. Furthermore, the key informant interview schedules allowed informants the opportunity to freely express their experiences concerning the subject of inquiry, as the researcher learns from the experience of informants at this point.

Another justification for the use of key informant interviews is that it is one of the most commonly used qualitative instruments for data collection in social research.

The major reason for its popularity and usage is because of its effectiveness in giving a human face to the research problem, and its rewarding experience for both the interviewee and interviewer alike. The key informant interview offers interviewee the opportunity to express themselves in a way other data collection instruments rarely offered. Furthermore, during key informant interviews, the informants were considered to be experts, and the interviewer considered learner in everything the informants can share about the research topic. Given the rural background of the respondents, questions were translated in local languages in order to encourage massive participation. Through random and proportional sampling techniques, a total of 255 respondents for the study were selected proportionately according to the population of yam farmers per local government area.

3.1 Sample Size Determination

The study adopted Fisher's (1963) sample size formula which is a formula used for an unknown population to determine the minimum sample size for a study. The formula is stated thus:

$$N = Z^2 P (1-P) / (d)^2 \quad (1)$$

Where:

N = the desired sample size (if the target population is greater than 10,000)

Z = the standard normal deviate at the required confidence level (1.96)

P = the proportion in the target population estimated to have characteristics of interest of the researcher (here is BSDP, 2016-2025 that an estimated 80% of Benue State population are involved in agriculture)

d = level of statistical significance 5% (standard value of 0.05)

Computation

By direct substitution into the formula, we have:

Z=1.96, P=0.80, D=0.05

$$n=1.96^2 (0.80) (1-0.80) / 0.05^2 \quad (2)$$

Then

$$n=3.8416 (0.80) (0.2) / 0.0025 \quad (3)$$

$$n=3.8416 (0.16) / 0.0025 \quad (4)$$

$$n=0.610336 / 0.0025 \quad (5)$$

n=244.1344 and n=244

Based on this, the adequate sample size for the study was 244 respondents based on Fisher's formula. The choice of Fisher's formula was because the population of interest (yam farmers) was unknown, since there is no official data of yam farmers in Benue State, but it is believed to exceed ten thousand (10,000 people).

3.1.1 Allocation of sample size per Local Government Areas selected for the study

Bourley's (1964) formula for allocation of sample size proportionately was adopted. The formula is presented thus:

$$Nh = n \times Nh / N \quad (6)$$

Where:

nh = Sample size per Local Government Area,

Nh = Total population in each Local Government Area,

N = Total population size and
n = Total sample size

Computation Process:

Katsina-Ala Local Government Area

nh = 244x 183,961/1,210,160
nh =37

Ukum Local Government Area

nh =244x175,360 /1,210,160
nh = 35

Gboko Local Government Area

nh = 244 x 307,351/ 1,210,160
nh = 62

Buruku Local Government Area

nh = 244x165,109/1,210,160
nh = 33

Otukpo Local Government Area

nh =244x234,349/1,210,160
nh = 47

Okpokwu Local Government Area

nh =244x144,030 /1,210,160
nh = 29

Thus, 37+35+62+33+47+29 = 243 (sample population distributed across selected Local Government Areas in Benue State, Nigeria).

3.2 Sampling Techniques

Cluster sampling, simple random sampling, purposive sampling and systematic sampling procedures were used for selecting a total of 255 respondents for the study. The choice of these techniques was to enable the researcher to adopt at different stages or levels the most appropriate sampling technique in order to arrive at an accurate and acceptable sample for the study. Sequel from above, Benue State was clustered into three agricultural zones namely; Eastern Agricultural Zone which comprised Ukum, Logo, Kwande, Ushongo, Katsina-Ala, Konshish and Vandeikya Local Government Areas, Central Agricultural Zone which comprised Gboko, Taaka, Guma, Buruku, Makurdi, Gwer, and Gwer-West Local Government Areas, while Southern Agricultural Zone comprised of Ado, Apa, Agatu, Oju, Obi, Okpokwu, Ohimini, Ogbadibo and Otukpo Local Government Areas (Daudu et al., 2009). These agricultural zones formed major cluster for the study.

Secondly, simple random sampling technique was used to sample two Local Government Areas in each of the clusters thus: in Benue Eastern agricultural zone, the study selected Ukum, and Katsina-Ala Local Government Areas, in Benue Central agricultural zone, Gboko and Buruku Local Government Areas were selected, while in Benue Southern agricultural zone, the study selected Otukpo and Okpokwu Local Government Areas. The process of simple random sampling selection of these LGAs was carried out thus: names of all the Local Government Areas under each cluster (agricultural zones) were written separately on pieces of paper. Each piece of paper was squeezed and dropped in a container labelled for the three (3) clusters of the state accordingly. A lucky dip was conducted using passer-by who was asked to pick two pieces of paper in each of the three containers with replacement. Through this process, six (6) Local Government Areas made the list. This was to give equal chances to all the Local Government Areas.

The simple random sampling technique process was repeated to select two council wards in each of the six (6) selected Local Government Areas for the study thus: six (6) containers were labelled with the name of the Local Government Areas that made the list. Each container had names of the council wards under the LGA written separately on pieces of paper, squeezed, and placed in. A lucky dip was carried out using a passer-by who was asked to pick with replacement two (2) pieces of paper in each container. Through this process, the study arrived at the selection of twelve (12) council wards for the study. The council wards that made the list include: *Boikyo*, and *Mbayenge* in Ukum Local Government Area, *Ikurav Tiev* I and *Tiir (Tongov* iii*)* in Katsina-Ala Local Government Area, *Yandev* North and *Mbadim* in Gboko Local Government Area, Mbaya and Mbakyaan in Buruku Local Government Area, *Ek*e and *Ojoga* in Okpokwu Local Government Area, and *Adoka-Icho* and *Otobi* in Otukpo Local Government Area. This process enabled the researcher to select two (2) council wards in each of the six (6) LGAs without bias since every ward had equal chance of belonging to the sample, thus giving a total of twelve (12) council wards for the study.

Lastly, a purposive sampling technique was used to sample respondents who cultivated yam crop for a period of not less than five years in each of the twelve (12) council wards selected from the study. These respondents were systematically selected. The first respondent (yam farmer) in each council ward was selected at random at his yam farm site as the starting point, while the subsequent respondents were fixed related to the first at intervals of 150 metres to arrive at the population of yam farmers designated per Local Government Area. This process was repeated across the twelve (12) council wards selected for study to sample respondents till the sub-total of 243 respondents for the study was arrived at and were administered with quantitative instrument of data collection at their firms. Furthermore, another purposive sampling technique was adopted to select one (1) key informant (adult yam farmer irrespective of sex) from the twelve (12) selected council wards to arrive at a sub-total of 12 respondents; two (2) key informants in each of the six (6) Local Government Areas of Benue State were selected as participants for key informant interview for ease of administration of both structured interview instruments and key informant interview guide to generate data needed for analysis of the phenomenon. The criteria used by the researcher for selecting participants for key informant interview guide was based on the size of the yam-farm owned (not less than one hectare) and the age of the participant (age of 40 years and above, irrespective of sex) thus given a grand total of 255 respondents for the study (see details in Table 1).

The justification of the purposive sampling technique used was to ensure that only yam farmers made the list. Besides, is the fact that the technique was convincing to the researcher since these “yam farmers” had adequate knowledge and were informed of the phenomenon. These were not ordinary yam farmers considering their age and the size of yam farm owned which explain their knowledge capacity. The key informant interview session was conducted at the premises of each of the key informant and was recorded using smart phone (Vivo Y15s) within the time frame of 35 minutes.

3.3 Analytical methods

The study also employed descriptive statistics such as pie charts, tables and percentages in order to analyse the data collected. Furthermore, the Student T-Test and analysis of variance (ANAOVA) were also applied, mainly to examine and compare the behaviour of the different groups which include the experimental (farmers who did not consistently apply the indigenous preservation practices) and the controlled or treatment group (those who consistently applied the method) in the study area. While the T-test is mostly applied to compare the differences between two research groups, ANOVA compares the variation in the mean of more than two groups. The third group in this case involves those who did not apply the indigenous preservation methods at all. Structural Equation Modelling (SEM) was also used to determine the combined effect of the various existing indigenous practices on the shelf life of yam in the study area, while the correlation test was applied to examine the nature and direction of variable relationship in the model. While these methods may be limited by their low predictive power, as well as inability to determine the degree of variable relationship, their usage is quite suitable due to the qualitative nature of responses expected from the respondents. Also, though the use of proportional sampling method is likely to yield some bias in the data collection process, this has been greatly reduced with the due to the careful manner of selection process.

4. RESULTS AND DISCUSSIONS

This section presents the results and analyses of the various test statistics.

4.1 Existing Indigenous Preservation Practices of Preserving Yams in Benue State, Nigeria

The data gathered indicated that yam farmers in the study area utilised various existing indigenous preservation practices in the area, aimed at reducing yam tuber postharvest losses to prolong the shelf life of stored yam tubers. Based on the priority scale of the respondents, 87 (34.11%) respondents utilised tridox *coatbutton* in fighting yam tuber postharvest losses, 63 (24.71%) respondents used white melon *cucumis* in checking issues of yam tuber postharvest losses, 33 (12.94%) respondents used mahogany as indigenous preservation practice for reducing yam tuber postharvest losses, 30 (11.76%) respondents indicated the use of scent leaves for fighting yam tuber postharvest losses, 23 (9.02%) respondents used wood ash for the control of yam tuber postharvest losses, 9 (3.53%) respondents used pawpaw leaves as material for checking yam tuber postharvest losses, 6 (2.35%) respondents indicated the use of *neem* leaves in fighting yam tuber postharvest losses, and 4 (1.57%) respondents used tobacco leaves to control yam tuber postharvest losses in the study area (see details in Table 1).

Table 1. Priority Utility List of Existing Indigenous Preservation Practices of Preserving Yam Tubers in Benue State

S/No	Existing indigenous preservation practices	Frequency (N=255)	Percentage
1	*Tridox coatbutton*	87	34.11
2	White melon *Cucumis*	63	24.71
3	Mahogany	33	12.94
4	Scent leaves	30	11.76
5	Wood Ash	23	9.02
6	Pawpaw leaves	9	3.53
7	*Neem* leaves	6	2.35
8	Tobacco leaves	4	1.57

Source: Field Survey (2022)

The information in Table 1 shows that most yam farmers in the study area used existing indigenous preservation practices to prevent yam tuber postharvest losses and prolong the shelf life of stored yam tubers. However, *tridox coatbutton* was predominantly utilised among yam farmers in the study area. The predominance of *tridoxcoatbutton* as an existing indigenous preservation practice among yam farming families stems from the commonality of the shrub/plant in every yam farm as "weed"; hence, it is readily available for usage.

4.1.1 Effectiveness of Existing Indigenous Preservation Practices in Reducing Postharvest Losses and Prolonging the Shelf Life of Stored Yam Tubers in Benue State

Indigenous preservation practices of preserving harvested yam tubers exist in every society, but the extent of effectiveness of such practices has always been a point of contestation among scholars. The extent of effectiveness of existing indigenous preservation practices in this work depends on the pattern of application of existing indigenous preservation practices by respondents in the study area. The application of indigenous preservation practices can either be "consistent" over time or only "sometimes", which forms the basis for analysis.

"Consistent application of existing indigenous preservation practices" refers to respondents who had applied existing indigenous preservation practices on harvested yam tubers in the last five years at all times, irrespective of circumstances. However, "At sometimes application of existing indigenous preservation practices" refers to respondents who applied existing indigenous preservation practices occasionally on harvested yams before storage despite their knowledge of available indigenous preservation practices in the study area in the last five years.

Data collected revealed that 198 (77.6%) respondents consistently applied existing indigenous preservation practices on harvested yams before storage in the study area to avert postharvest losses and enhance the prolonged shelf life of stored yams in the last five years, while 57 (22.4%) respondents did not consistently apply existing indigenous preservation practices on harvested yams before storage to fight postharvest losses and enhance the prolonged shelf life of stored yams in the study area in the last five years.

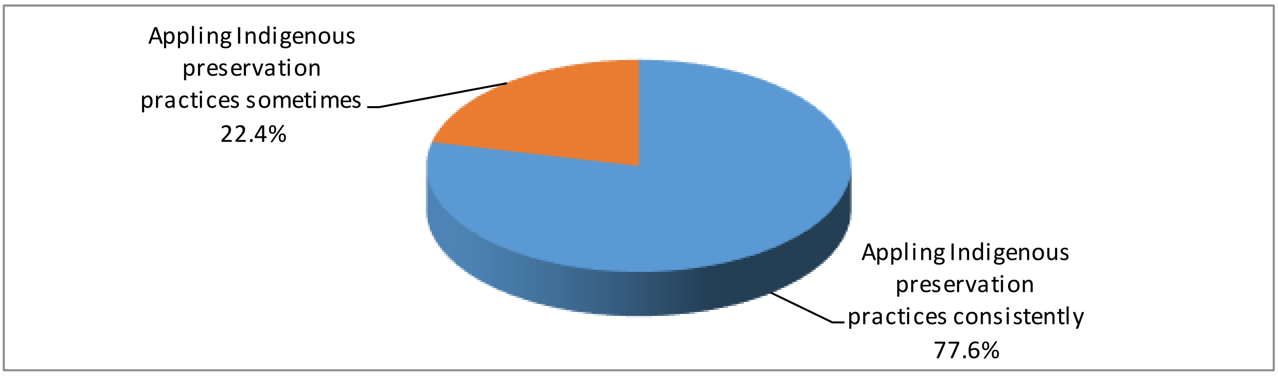

Figure 1. Application of Existing Indigenous Preservation Practices by Respondents in Benue State

Source: Author's Construction based on Data obtained from Field Survey (2022)

The data in Figure 1 reveal that the majority (77.6%) of the respondents in the study area applied one or a combination of existing indigenous preservation practices consistently on harvested yams to check incidences of postharvest losses in stores, while 22.4% applied existing indigenous preservation practices occasionally (not at all times) in fighting yam postharvest losses in the area within the period under study. These two categories of yam farmers constituted the basis for the examination of the extent of effectiveness of existing indigenous preservation practices in the study area in terms of prolonging the shelf life of stored yam tubers.

4.1.2 Assessment of the Improvement in the Shelf Life of Yam Tubers Stored Using Existing Indigenous Preservation Practices

The section examined the extent to which the shelf life of stored yam tubers among yam farmers using existing indigenous preservation practices could be improved in the study area. The data collected showed that the majority of respondents who applied existing indigenous preservation practices consistently had a prolonged shelf life of stored yams above 6 months, with 49.49%.

Out of 58 (22.75%) respondents who had prolonged shelf life of stored yam tubers up to 2-3 months in the study area, 17.68% applied existing indigenous preservation practices consistently, while 40.35% applied existing indigenous preservation on stored yam sometimes. Out of 83 (32.54%) respondents with a prolonged shelf life of stored yams between 3-5 months in the study area, 32.83% applied existing indigenous preservation practices consistently, while 31.58% applied existing indigenous preservation practices only sometimes on harvested yam tubers stored. While FAO (1998) estimated a maximum average storage life in the barns to be 6 months, Maalekuut et al. (2014) equally estimated the average storage life of 5 months. Out of 144 (44.71%) respondents with over 6 months prolonged shelf life of stored yams, 49.49% utilised existing indigenous preservation practices consistently on yam tubers stored, while 28.07% utilised existing indigenous preservation practices only sometimes on harvested yam tubers stored (see details in Table 2).

Table 2. Prolonged Shelve Life of Stored Yam Tubers Applied with Existing Indigenous Preservation Practices

Prolonged shelve life of yams in stores	Application of existing indigenous preservation practices		
	consistently	sometimes	Total
2-3 months	35 (17.68%)	23 (40.35%)	58 (22.75%)
3-5 months	65 (32.83%)	18 (31.58%)	83 (32.54%)
Above 6 months	98 (49.49%)	16 (28.07%)	114(44.71%)
Total	**198 (100%)**	**57 (100%)**	**255 (100%)**

Spearman Rank Correlation coefficient = 0.226, Asymptotic Standardized Error = 0.62 (significant at 5% level)
Mean Shelf Life = 5.7 months, Measure of Agreement (Kappa) = 0.060
Source: Field Survey (2022)

Cross-tabulated results indicate that 40.4% of the respondents who sometimes applied the existing indigenous preservation practices and had their yam shelf life extended by 1-3 months witnessed an average of 39.7% prolonged life span. Conversely, average prolonged life span of yam increases by 60.3% for those who consistently applied the methods (17.7% of the same group). As for the second category (3-5 months), average shelf life was extended by 21.7% for those who sometimes applied the method (representing about 31.6%). A drastic improvement in the shelf life was however recorded for those who consistently applied and realised shelf life extension of between 3-5 months (or 32.8% of the within total) was however observed.

It could further be inferred that there was a progressive decline to the tune of 14.0% of prolonged life for the "sometimes applied" group for respondents who experienced above 5 months of prolonged life span of yam. On the other hand, this category witnessed a tremendous boost of about 86% for the "consistently applied" group. Overall, only 22.4% of the respondents falls within the "sometimes applied" group, while 77.6% of the distribution "consistently" stored yams using the traditional methods of yam preservation. This implies that consistent application of traditional preservation practices is highly effective in improving the shelf life of yam in the study area. This finding agrees with that of Shambe (2017) for Benue State, Okigbo (2004) for South East Nigeria, William (2008), as well as Okigbo and Nmeka (2005). It also contradicts the findings of Odora (2001), Dei (2002), and Cheri (2019). The variations in submissions could be due to differences in scope, sample size, methodologies adopted, and the heterogenous composition of respondents' behaviour observed.

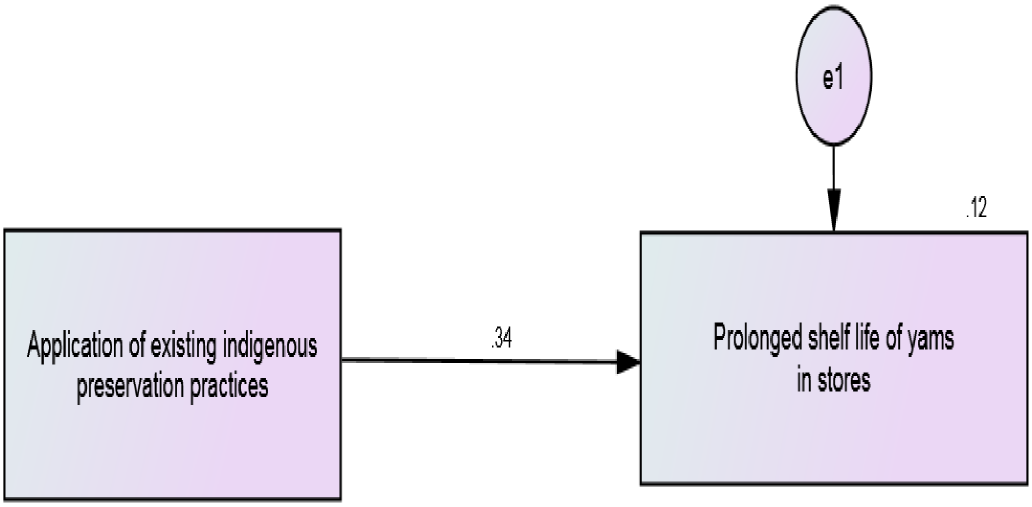

Figure 2. Showing the Output of the Standardised values for the effect of application of existing indigenous preservation practices on the shelf life of yams in Benue State

Source: authors' computations using SPSS

Figure 2 reveals that the effect of application of the existing indigenous yam preservation practices led to the overall improvement in the shelf life of stored yams by 34%. This implies that when consistently applied, these methods have the capacity to appreciably boost the life span and thus facilitate the retention in the use and market value of yam products in the study area.

The T test for prolonged shelf life of stored yams and application of existing indigenous preservation practices by yam farmers in Benue State showed a significant difference in the prolonged shelf life of stored yam tubers among farmers who consistently applied existing indigenous preservation practices and those who did not consistently apply the practices on stored yams in the study area. Lancaster & Coursey (1984) obtained similar results.

Table 3. T-test for Significance of the Prolonged Shelve Life and Application of Existing Indigenous Preservation Practices in Benue State

Length of shelve life using indigenous preservation practices	F	Sig.	T	Df	Sig.(2 tailed)
Equal variance assumed	20.614	.000	1.981	250	.049
Equal variance not assumed			5.297	220	.000

Source: Field Survey, 2022

From Table 3, the F-statistic =20.614, t-statistic =1.981, and P value=.049 were obtained. P<0.05 (alpha level) implies that there is a statistically significant difference in terms of prolonged shelf life of stored yam tubers among respondents who applied existing indigenous preservation practices consistently and those who did not consistently apply existing indigenous preservation practices in the study area. This implies that yam farmers who applied existing indigenous preservation practices of stored yam tubers consistently often experienced a prolonged shelf life, leading to increased return on investment (revenue) and food security.

The ANOVA in Table 4 shows a P<0.05, implying that existing indigenous preservation practices are statistically significant in terms of differences among yam farmers who applied indigenous preservation practices consistently in the study area and those who did not; hence, existing indigenous preservation practices are highly effective.

Table 4. ANOVA of Prolonged Shelf Life by Existing Indigenous Preservation Practices in Benue State

	Sum of Squares	Df	Mean square	F	Sig.
Between Groups	.634	2	.317	3.608	.029
Within Groups	21.886	249	.088		
Total	**22.520**	**251**			

Source: Field Survey (2022)

Inferences from the data collected showed that consistent application of existing indigenous preservation practices is effective in reducing pathogenic attack and prolonging the shelf life of stored yam tubers above 6 months. The normality test showed a Shapiro–Wilk statistical value of 0.485 for prolonging the shelf life of stored yam tubers, with a P value of 0.000. These findings imply that data for the variable were approximately normally distributed, hence the applicability of nonparametric statistics (Razali & Wah, 2011; Shapiro &Wilk, 1965).

Chi-square tests for prolonged shelf life of stored yam tubers applied with indigenous preservation practices in the study area showed Pearson chi-square values of 101.762a, asymptotic significance (2-sided) = 0.00, degree of freedom 1, at alpha level of significance 0.05). Since the P value = 0.000<0.05, the study rejects the null hypothesis that the "application of existing indigenous preservation practices is not effective in prolonging the shelf life of yam tubers in the study area" and accepts the alternative hypothesis that the "application of existing indigenous preservation practices is effective in prolonging the shelf life of yam tubers in the study area".

A symmetric Phi value of 0.635 was obtained. This shows a moderate positive association between the application of existing indigenous preservation practices and the prolonged shelf life of stored yam tubers in the study area. This finding indicates that existing indigenous preservation practices are moderately effective in prolonging the shelf life of stored yam tubers beyond 6 months in the study area.

Table 5. Chi-Square Tests on prolonged Shelf Life using existing Indigenous Preservation Practices

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	101.762[a]	1	.000
Likelihood Ratio	88.647	1	.000
Linear-by-Linear Association	101.358	1	.000
Number of Valid Cases	**255**		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.36.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.635	.000
	Cramer's V	.635	.000
	Contingency Coefficient	.536	.000
N of Valid Cases		**255**	

Source: Field Survey (2021)

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, it is evident that a consistent application of existing indigenous preservation practices is highly effective in reducing incidences of yam tuber postharvest losses by prolonging their shelf life above 6 months or average of 34% of their life span. This is supported by the significant value of chi square at 5% level and a symmetric Phi value of 0.635. This shows a moderate positive association between the application of existing indigenous preservation practices and the prolonged shelf life of stored yam tubers in the study area. Average prolonged life span of yam increases by 60.3% for those who consistently applied the indigenous preservation methods, with Tridox coatbutton being the most effective and commonly used method (34.11% of respondents), followed by white melon Cucumis (24.71%), mahogany (12.94%), scent leaves (11.76%), wood ash (9.02%) pawpaw leaves (3.53%), neem leaves (2.53%) and tobacco leaves (1.57%). These findings have grave implications for mitigating postharvest losses and enhancing food security in Benue State, given the capacity of these methods to reasonably lengthen the life span and thus facilitate the retention in the use and market value of yam products in the study area.

On the basis of this finding, the study recommends that the indigenous preservation practices of yam tubers should be intensified in the study area. Besides, government and nongovernmental organisations should provide both financial and technical assistance to rural yam farming families, in terms of soft agro-loan facilities. Yam farmers are encouraged to form cooperative societies that may allow them to access these loans in a timely manner. This will aid yam farmers in the expansion of storehouses to accommodate the increasing quantity of yam tubers harvested, provide good ventilation to store yam tubers and free traffic needed during the removal of sprout development to avert limiting existing indigenous practices from achieving optimal yam tuber postharvest losses and prolong the shelf life of stored yam tubers in the study area. Again, farmers who intend to achieve a prolonged shelf life for their stored yam tubers must avoid the practice of inconsistent application of indigenous yam preservation practices. The Benue State Ministry of Agriculture in conjunction with Joseph Sarwuan Tarka University Makurdi should identify, modernise and boost the large-scale production of these methods through scientific research. However, care should be taken to ensure that the use of some of these methods does not deteriorate environmental quality. For instance, procuring wood ash necessarily requires cutting down trees in order to produce ashes, or large-scale plucking of neem, scent, or pawpaw leaves may exacerbate the pace of deforestation in the area. On the contrary, given the availability, replenishable, and perennial nature of some of these trees, that concern could be easily overcome. This study was limited by the cross-sectional nature of data, as well as the illiterate background of yam farmers which made it difficult for some of them to fully participate in the survey process due to ignorance. Also, the choice of sample frame may have yielded some bias due to the difficulty in clearly establishing the population of yam farmers in the study area.

This study therefore suggests that the replication of a similar study but with a larger scope may be at the national level, where the scenarios for the various regions could be explored, using parametric tools such as panel data analysis for a reasonable period of time. Also, a comparative study of the relative efficacy of the traditional and modern preservation method should equally be investigated. This may give room for a more informed decision for policy prescription. It is important to reiterate that the above findings and recommendations are crucial to minimising postharvest yam loss, which is a common problem among yam farmers, stimulating the agricultural value chain, and improving food security in the study area.

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