



Original Paper

## Impact of Storage Methods on Sweet Potato Spoilage in Plateau State Nigeria

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**Abstract**—Spoilage of sweet potato could be enormous when inadequate methods of storage are used. This research investigated impact of methods of storage on spoilage of sweet potato in three major markets of Plateau State Nigeria. Data for the study were obtained from sellers of sweet potato in Yan Doya market, New market and Farin Gada market of Plateau State through administration of questionnaires. Analysis of the data was carried out using descriptive statistics, Pearson Product Moment Correlation (PPMC), F-test statistics, t-test and Multiple Linear Regression (MLR) with backward elimination procedure. Results from descriptive statistics showed that majority of sweet potato sellers adopted use of sack for storage of their goods. The second method commonly used for storage of sweet potato in the study area was found to be root cellar method. Pair-wise application of PPMC indicated that spoilage of sweet potato was positively correlated with adopted methods of storage which suggested existence of relationship among the variables. Analysis using F-test statistics indicated that the relationship did not occur by chance between the variables hence t-test aided determination of which independent variables mainly influenced the dependent variable of the study. From the use of MLR with backward elimination procedure, spoilages from sacks and root cellars methods were the independent variables which mainly influenced the total spoilage of sweet potato in Plateau State Nigeria. Therefore, policy holders in Plateau State need to offer agricultural extension services that would provide modern storage facilities or educate sellers of sweet potato on best way to use both basket and root cellar methods which were their adopted methods commonly used for storage of sweet potato.

**Keywords**— Potato, Spoilage, Storage, Method

### I. INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is one of the root and tuber crops commonly grown in Plateau State Nigeria. It is a creeping dicotyledonous plant which serves as food to some people in about 4,200,442 population of Plateau State [1]. Its tuber is a good source of glucose and has leaves that can be eaten by animals and humans as vegetables. Analyses of chemical constituents of both leaves and tubers of sweet potato indicated that it consists of sugar, starch, protein,  $\beta$ -carotene, vitamin A, vitamin B complex, ascorbic acid (vitamin C), phenolic

compounds and other constituents that could help humans to reduce degeneration of neurones occurring due to aging [2-7].

While some residents of Plateau State boil tubers of sweet potato as food for consumption, others fry it with groundnut oil or vegetable oil before eating. Some other class of residents of Plateau State pound their boiled sweet potato and consumed it in pounded form. Its use among local residents also involves sweetening of gruel with dried form of sweet potato. Other general uses of sweet potato include milling its sliced, sun-dried form as flour for making different kinds of snacks.

As found in the research of Afuape et al. [8], increase in production of sweet potato in Nigeria and Africa as a whole is due to increase in area of land cultivated rather than increase in yield per hectare of land. Other researches on production environment, yield, genotype, morphological characterisation, agronomic traits alteration can be found in literature [9-13].

Sweet potato is a highly delicate and easily damaged crop which is very difficult to store for a long period of time [14]. Those in sales of sweet potato in Plateau State usually handle fresh sweet potato and are often faced with the challenge of proper storage due to its high moisture content. Some of the dealers in sales of sweet potato in Plateau State sometimes run at loss due to large quantity of spoilage resulting from poor storage facilities. This could pose a significant drawback to meeting domestic needs of the growing population of Plateau State in Nigeria.

Many sellers of sweet potato in Plateau State do not have financial ability to adopt modern methods of storage. The types of sweet potatoes commonly found in the state are those with long-elliptic storage root shape and those with irregular storage root shape. They have skin colour which is commonly pale yellow with only a few having dark purple skin colour. Those with pale yellow skin type usually have cream flesh colour and those with dark purple skin colour type have white flesh colour. From interaction with some sellers of sweet potato in Plateau State, majority of them stated that farmers usually do sequential harvesting of sweet potato. This means that farmers usually harvest their sweet potato only when they want to eat or sell them and the remaining portions are left in the ground until when

they want to sell the next batch of their farm produce in order to reduce wastages arising from inadequate storage facilities. While some sellers of fresh sweet potato store them in sacks, others use woven baskets, root cellars and basement methods.

The research of Vithu et al. [15] investigated post-harvest handling of sweet potato with emphasis on engineering aspect of its processing and concluded that small and medium scale equipment are not readily available to reduce qualitative and quantitative losses. Oduola et al. [16] listed percentage of bacteria and fungi causing spoilage of sweet potato and concluded that such pathogens gained entry through the openings caused by injuries to its tubers. Ray and Ravi [17] considered post-harvest handling of the farm produce relative to weevil pest and micro organisms such as fungi with suggestions on control measures which include bio-control, curing, gamma irradiation, hydro warming, storage in sand and saw dust and fungicide treatment [21, 22]. While investigating post-harvest handling of sweet potato under controlled atmospheric conditions, Oladoye et al. [18] suggested that it is advantageous to use iprodione as curing agent for sweet potato tubers before storage. The study of McCoonnell et al. [19] considered post-harvest handling with emphasis on shredded sweet potatoes. They concluded that modified atmospheric packaging (MAP) and semi permeable polymeric material performed better than shredded sweet potatoes stored in air. This is because shredded sweet potato stored using MAP showed fewer activities of aerobic and enteric bacteria.

While considering Bokokos local government area of Plateau State in Nigeria, Onuwa et al. [20] analysed economics of sweet potato production. They concluded that its production is significantly affected by socio economic characteristics of respondents in their survey. However, their study was based on production of sweet potato; they did not consider spoilage and methods of storage relative to market place and sellers. There have not been researches in literature with specific objective of determining spoilage relative to methods of storage among sweet potato sellers in markets along its value chain in Plateau State.

Motivation to embark on this study hinged on possibility of increasing food supply in Plateau State through reduction of wastages due to spoilage of sweet potato. Another factor is to investigate most commonly used method of storage for sweet potato in Plateau State. This could facilitate interventions that would help sellers to shift to a better storage method or to possibly improve their most commonly adopted storage method in Plateau State, Nigeria.

The aim of this study was to investigate impact of storage methods on sweet potato spoilage in Plateau State Nigeria. The specific objective was to determine the most commonly adopted method of storage for sweet potato in the study area. The focus of this study is not on production of sweet potato but on the market place where sellers handle the farm produce before selling them to final consumers. The remaining part of this paper is organised as follows: section 2 centres on materials and methods, section 3 focuses on results and discussion and finally conclusion comes up in section 5.

## II. MATERIALS AND METHODS

### A. Study Area

The study areas for this research are three major markets in Plateau State. They are Yan Doya market, New market and Farin Gada market. The Yan Doya market is close to Terminus market in Jos North Local Government Area of Plateau State. It is a market where varieties of root and tuber crops are sold to both wholesalers and retailers. The market has its association called National Association of Root and Tuber Crops (NARTC) that controls the activities of their businesses with involvement of traders in the market.

The second study area for this research is New market which is situated behind police barrack along Bauchi road in Jos North Local Government Area of Plateau State. Different sections exist in this market with some specific types of goods. The section where sweet potato sellers are located consists of sheds under which goods are stored and some sweet potatoes are displayed for buyers to see. Activities in the market are controlled by a union of traders headed by a chairman whose work include resolving dispute among traders, setting up committees to collect local security contributions and setting up committees to regulate other activities in the market. The third study area is Farin Gada market where all kinds of vegetables can be bought. Farin Gada is a large market where supplies of sweet potato and other food stuffs are available for indigenes and other residents within Plateau State. Some quantities of it are transported from the market to other states in Nigerian federation. It is along Sabo Layi road in Plateau State and has capacity to meet the vegetable needs of both wholesalers and retailers. The market also has its local association that control activities of members in the market.

### B. Design Framework

This study was designed to investigate impact of methods of storage on spoilage of sweet potato in Plateau State, Nigeria. Therefore, the design framework shown in Fig. 1 indicates effect of spoilage from each adopted method of storage for sweet potato on total spoilage from all methods.

The null hypothesis of this study states that spoilage from methods of storage such as refrigeration, sack, root cellar and basement do not have significant effect on total spoilage of sweet potato in the three main markets of Plateau State and the alternate hypothesis states that spoilage from methods of storage such as refrigeration, sack, root cellar and basement have significant effect on total spoilage of sweet potato in the three main markets of Plateau State.

### C. Sampling Technique and Data Collection

Purposive sampling technique was employed in the choice of markets for this study. However, simple random sampling technique was adopted for collection of data from 400 sweet potato sellers in three main markets of Plateau State, Nigeria which was based on primary source of data. The primary source of data here means that data were obtained directly from dealers in sales of sweet potato in the study areas through administration of questionnaires.

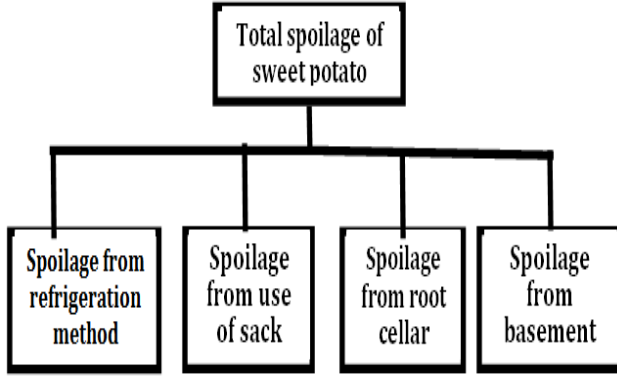


Fig. 1. Representation of total spoilage of sweet potato on spoilage from different methods of storage in Plateau State Nigeria

#### D. Data Analysis

Data for this research were analysed using descriptive statistics, Pearson Product-Moment Correlation (PPMC), F-test statistics, t - test, multiple linear regression (MLR) with backward elimination procedure with the aid of Statistical Package for Social Sciences (SPSS).

#### E. Model Specification

Let F be total spoilage from adopted methods of storage by sellers of sweet potato in the selected markets of Plateau State, Nigeria. Let  $X_i$  ( $i = 1, 2, 3, 4$ ) represent spoilage of sweet potato from each method of storage and  $p_i$  some parameters associated with spoilage from each method of storage, then multiple linear regression is defined by:

$$F = g(X_i, p_i) + \epsilon \quad (1)$$

where  $g(X_i, p_i)$  is a function representing spoilage due to each method of storage of sweet potato in the study area and  $\epsilon$  is the associated functional error. Specifically for four independent variables representing spoilage from refrigeration, sack, root cellar and basement storage method, equation (1) gives multiple linear regression

$$F = p_4X_4 + p_3X_3 + p_2X_2 + p_1X_1 + p_0 + \epsilon \quad (2)$$

where  $g(X_i, p_i) = p_4X_4 + p_3X_3 + p_2X_2 + p_1X_1 + p_0$  and  $X_4$  is the spoilage of sweet potato from the use of refrigeration method,  $X_3$  is spoilage of sweet potato from the use of sack method,  $X_2$  is spoilage of sweet potato from the use of root cellar method and  $X_1$  is spoilage from the use of basement method of storage. The  $p_0$  is a constant term and  $p_1, p_2, p_3$  and  $p_4$  are coefficients of spoilage from the use of basement, root cellar, sack and refrigeration methods respectively. Pearson Product Moment Correlation (PPMC) is defined in a pairwise mode as:

$$r = \frac{N \sum X_i F - (\sum X_i)(\sum F)}{\sqrt{[N \sum X_i^2 - (\sum X_i)^2][N \sum F^2 - (\sum F)^2]}} \quad (3)$$

where  $X_i$  ( $i = 1, 2, 3, 4$ ) are spoilage of sweet potato from each method of storage, F is total spoilage from adopted methods of

storage by sellers of sweet potato in the selected markets of Plateau State, Nigeria and r is the correlation coefficient such that  $-1 \leq r \leq 1$ .

### III. RESULTS AND DISCUSSION

The results from Table 1 show that storage method mostly adopted by sweet potato sellers in the study area is the use of sacks with frequency of 216 sellers out of 400 sellers sampled. The commonly used sacks have holes through which oxygen could reach the stored commodity. The second method of storage that is also popularly used is root cellar method with 117 sellers adopting it as their most frequently used method of storage. While 54 sweet potato sellers adopted basement method, only 6 sweet potato sellers indicated that they adopted refrigeration method for storage of sweet potato in the main markets of Plateau State.

TABLE I. DISTRIBUTION OF SWEET POTATO SELLERS IN YAN DOYA MARKET, NEW MARKET AND FARIN GADA MARKET OF PLATEAU STATE.

Method of Storage	Frequency	Percentage %
Refrigeration	6	1.5
Sack	216	55.0
Root Cellar	117	29.8
Basement	54	13.7
Total	393	98.3

Out of survey of 400 sweet potato sellers, only 393 sellers indicated their mostly used method of storage.

From Fig. 2, distribution of sweet potato sellers by ethnic groups shows that those from Hausa ethnic group have highest number of people in the sampled markets than other ethnic groups. The second ethnic group with very large presence in the sampled markets is Berom ethnic group. Those from Yoruba, Fulani, Igbo and other ethnic groups ranked third, fourth, fifth and sixth positions respectively among those involved in sales of sweet potato in the sampled markets.

From results presented in Table 2, Pearson Product Moment Correlation (PPMC) shows positive correlation of spoilage from refrigeration, sack, root cellar and basement with total spoilage.

TABLE II. PAIRWISE PPMC OF THE SPOILAGE FROM REFRIGERATION, SACK, ROOT CELLAR AND BASEMENT WITH TOTAL SPOILAGE..

	Spoilage from Refrigeration Method	Spoilage from the use of Sack Method	Spoilage from Root Cellar Method	Spoilage from Basement Method
Total Spoilage	0.183	0.292	0.305	0.179

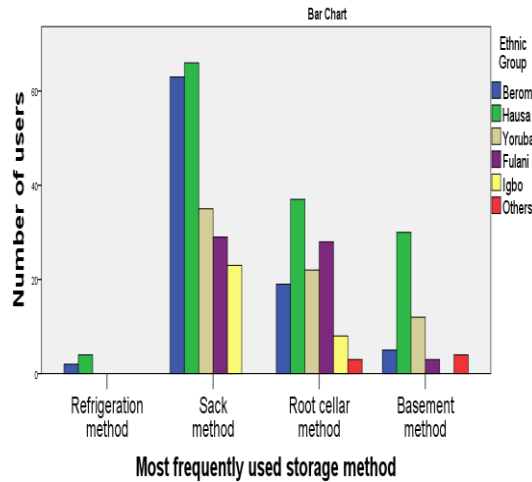


Fig. 2. Distribution of sweet potato sellers by ethnic groups in Yan Doya market, New Market and Farin Gada market of Plateau State.

The PPMC was adopted by pair-wise comparison of spoilage from each method of storage for sweet potato with total spoilage from all adopted methods. The positive correlation results shown in Table 2 means that increase in total spoilage of sweet potato varies directly with spoilage from each method of storage. This suggests that there is association between the tested categorical variables with PPMC values of 0.305, 0.292, 0.183, 0.179 of spoilage from root cellar, sack, refrigeration, basement respectively with total spoilage from methods of storage used. This consequently indicates existence of some degrees of association for root cellar, sack, refrigeration and basement with total spoilage from methods of storage used.

Results from Table 3 indicate that 12.5% variation occurs in total spoilage when associated with spoilage from different methods storage.

TABLE III. MODEL SUMMARY FOR RESPONSE OF TOTAL SPOILAGE TO SPOILAGE FROM DIFFERENT METHODS OF STORAGE.

Model <sup>b</sup>	R	R-Square	Adjusted R-Squared	Std Error of the Estimate
1	0.354 <sup>a</sup>	0.125	0.116	0.701

<sup>a</sup>. Predictor: (constant), spoilage from basement, refrigeration, sack and root cellar methods

<sup>b</sup>. Dependent variable: Total spoilage of sweet potato

To investigate whether or not the value of R=0.354 shown in Table 3 occurs by chance, F-test statistics is obtained as shown in Table 4.

TABLE IV. F-TEST STATISTICS FOR SPOILAGE OF SWEET POTATO FROM BASEMENT, REFRIGERATION, SACK AND ROOT CELLAR METHODS,  $\alpha = 5\%$  LEVEL OF SIGNIFICANCE.

Model <sup>d</sup>	Sum of squares	df	Mean square	F	p-value
Regression	27.110	4	6.777	13.787	0.000 <sup>c</sup>
Residual	189.260	385	0.492		
Total	216.369	389			

<sup>c</sup>. Predictor: (constant), spoilage from basement, refrigeration, sack and root cellar

<sup>d</sup>. Dependent variable: Total spoilage of sweet potato

From results shown in Table 4,  $p < 0.05$  indicate that there exists a significant spoilage predictor affecting total spoilage of sweet potato at 95% confidence bound. However, F-test statistics could not tell us which or how many of the independent variables is contributing mainly to influence the dependent variable; we employ t-test as shown in Table 5.

TABLE V. F-TEST STATISTICS FOR SPOILAGE OF SWEET POTATO FROM BASEMENT, REFRIGERATION, SACK AND ROOT CELLAR METHODS,  $\alpha = 5\%$  LEVEL OF SIGNIFICANCE.

Model <sup>e</sup>	B	Std Error	Beta	t	p-value	L Bound	U Bound
(constant)	1.897	0.103		18.435	0.000	1.695	2.099
Spoilage from refrigeration	0.032	0.043	0.041	0.760	0.448	-0.051	0.116
Spoilage from sack	0.110	0.033	0.186	3.337	0.001	0.045	0.175
Spoilage from root cellar	0.146	0.042	0.200	3.497	0.001	0.064	0.228
Spoilage from basement	0.008	0.034	0.013	0.246	0.806	-0.059	0.075

<sup>e</sup>. Dependent variable: Total spoilage of sweet potato

It can be seen from Table 5 as determined by t-test statistics that spoilage from refrigeration and basement methods are not statistically significant  $p > 0.05$  after checking for effects of other predictor variables on total spoilage of sweet potato from different methods of storage. However, spoilage from sack and root cellar show that they are statistically significant  $p < 0.05$  after checking for effects of other predictor variables on total spoilage of sweet potato from different methods of storage. To determine major contributing variables and to remove predictor variables which do not have significant relationship with total spoilage of sweet potato, we use backward elimination procedure.

On first application of backward elimination procedure, spoilage from basement method was removed because it was the least statistically significant predictor variable  $p = (0.806) > 0.05$ . The re-fit of the remaining predictor variables after removal of spoilage from basement method gives the values shown in Table 6.

It can be seen that the least significant predictor variable (spoilage from refrigeration) is the one with highest p-value ( $p$

= 0.414) from t-test statistics which is shown in Table 6. On further application of backward elimination procedure to values obtained in Table 6, we obtain results shown in Table 7.

TABLE VI. MODEL PARAMETERS FOR SPOILAGE OF SWEET POTATO AFTER FIRST APPLICATION OF BACKWARD ELIMINATION PROCEDURE..

Model <sup>e</sup>	B	Std Error	Beta	t	p-value	L Bound	U Bound
(constant)	1.903	0.100		19.039	0.000	1.706	2.099
Spoilage from refrigeration	0.034	0.042	0.043	0.817	0.414	-0.048	0.117
Spoilage from sack	0.113	0.032	0.190	3.563	0.000	0.050	0.175
Spoilage from root cellar	0.147	0.041	0.202	3.587	0.000	0.067	0.228

<sup>e</sup> Dependent variable: Total spoilage of sweet potato

TABLE VII. MODEL PARAMETERS FOR SPOILAGE OF SWEET POTATO AFTER SECOND APPLICATION OF BACKWARD ELIMINATION PROCEDURE

Model <sup>e</sup>	B	Std Error	Beta	t	p-value	L Bound	U Bound
(constant)	1.937	0.091		21.368	0.000	1.759	2.116
Spoilage from sack	0.116	0.031	0.196	3.693	0.000	0.054	0.177
Spoilage from root cellar	0.169	0.039	0.218	4.118	0.000	0.083	0.235

<sup>e</sup> Dependent variable: Total spoilage of sweet potato

From Table 7, after second application of backward elimination procedure, all independent variables have significant relationship with dependant variables ( $p < 0.05$ ) at 95% confidence bound. Consequently, use of values from Table 7 with equation (2) gives the following multiple linear regression equation

$$F = 0.116 X_3 + 0.169 X_2 + 1.937 \quad (4)$$

where  $F$  is the total spoilage of sweet potato and  $X_3$  is the spoilage of sweet potato from the use of sack method,  $X_2$  is spoilage of sweet potato from the use of root cellar. From (4), it can be observed that the frequently used methods for preservation of sweet potato in the study areas are the use of sack and root cellar methods.

#### IV. CONCLUSION

In this study, analysis of the effect of spoilage of sweet potato from different methods of storage on total spoilage of sweet potato was carried out in three major markets of Plateau State, Nigeria. Results from descriptive statistics show that more sweet potato sellers use sacks to store sweet potato than other methods of storage. It was also found that the second commonly used method of storage was root cellar method. Results from pairwise comparison of spoilage of sweet potato with adopted methods of storage using PPMC indicate positive

correlation thereby establishing relationship between the tested variables. Further analysis using F-test statistics, t-test and multiple linear regression with the aid of backward elimination procedure showed that spoilages from the use of sacks and root cellars have significant effect on total spoilage of sweet potato in Plateau State than other methods of storage. Therefore, in order to reduce spoilage of sweet potato due to these two most frequently used methods of storage, it is imperative for policy holders in Plateau State to either provide modern storage facilities or educate sweet potato sellers on best way to use their frequently adopted methods of storage.

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#### REFERENCES

- [1] National Bureau of Statistics (2017). Demographic statistics bulletin, Federal Republic of Nigeria. Vol 3, www.nigerianstat.gov.ng., accessed 21 February 2022
- [2] Woolfe, J.A. (1992). Sweet potato: an untapped food resource. Cambridge University Press.
- [3] Teow, C.C., Truong, V-D., McFeeters, R.F., Thompson, R. L., Pecota, K.V., Yencho, G.C. (2007). Antioxidant activities, phenolic and  $\beta$ -carotene contents of sweet potato genotypes with varying flesh colours. Food Chemistry, 103: 829-838.
- [4] Ji, H., Zhang, H., Li, H., Li, Y. (2015). Analysis on the nutrition composition and antioxidant activity of different types of sweet potato cultivars. Food Nutrition Science, 6, 161-167, doi: 10.4236/fns.2015.61017.
- [5] Kosieradzka, I., Borucki, W., Matysiak-kata, I., Szopa, J., Sawosz, E. (2004). Transgenic potato tubers as a source of phenolic compounds. Localization of anthocyanins in the peridermis. Journal of Animal Feed Science, 13, 87-92.
- [6] Bovel-Benjamin, A.C. (2007). Sweet potato: A review of its past, present and future role in human nutrition. Adv Food Nutr Res, 52, 1-59, doi: 10.1016/s1043-4526(06)52001-7. PMID:17425943.
- [7] Mascio, P.D., Raiser, S. & Sies, H. (1989). Lycopene as the most efficient biological carotenoid singlet oxygen quencher. Archives of Biochemistry and Biophysics, 274(2), 532-538.
- [8] Afuape, S.O., Okocha, P.I. and Njoku, D. (2011). Multivariate assessment of the agromorphological variability and yield components among sweet potato (*Ipomoea batatas* (L.) Lam) landraces. African Journal of Plant Sciences, 5(2), 123-132
- [9] Reddy, R., Soibam, H., Ayam, Y.S., Panja, P., Mitra, S. (2018). Morphological characterization of sweet potato cultivars during growth, development and harvesting. Indian Journal of Agricultural Resources. doi: 10.18805/IJAR.A-4798.
- [10] Ozturk, G. (2021). Field performances of different seedling types used in sweet potato [*Ipomoea batatas* (L.) Lam] growing. Turkish Journal of Food Crop, 26, 54-59
- [11] Wariboko, C. And Ogidi, A. (2014). Evaluation of the performance of improved sweet potato (*Ipomoea batatas* L. Lam) varieties in Bayelsa State, Nigeria. African Journal of Environmental Science Technology, 8, 48-53.
- [12] Gurmu, F., Hussein, S., Laing, M. (2017). Genotype-by-environment interaction and stability of sweetpotato genotype for root dry matter,  $\beta$ -carotene and fresh root yield. Open Agric, 2, 473 -485.
- [13] Ngailo, S., Shimelis, H., Sibiyi, Mtunda, K., Mashilo, J. (2019). Genotype-by-environment interaction of newly-developed sweet potato genotypes for storage root yield, yield-related traits and resistance to sweet potato virus disease. Heliyon.5:e01448.

- [14] Hall, A.J., Devereau, A. D (2000). Low-cost storage of fresh sweet potatoes in Uganda: Lessons from participatory and on-station approaches to technology choice and adaptive testing. *Outlook on Agriculture*. Thousands Oaks, California: SAGE publishing, 29(4), 275-282, doi: 10.5367/00000000101293347.
- [15] Vithu P, Dash, S. K. & Rayaguru, K (2019). Post-Harvest Processing and Utilization of Sweet Potato: A Review, *Food Reviews International*, 1 - 37, doi: 10.1080/87559129.2019.1600540
- [16] Oduola, A. A., Awojobi, K. O., Adeyemo S. M. (2018). Microorganisms associated with post harvest spoilage of sweet potatoes in Ile-Ife, Nigeria. *Journal of Microbiology Research*, 8(1): 1-8.
- [17] Ray, R.C., Ravi, V. (2005) Post harvest spoilage of sweetpotato in tropics and control measures. *Critical Reviews in Food Science and Nutrition*, 45(7-8), 623 – 644, doi: 10.1080/10408390500455516.
- [18] Oladoye, C. O., Connerton, I. F., Kayode, R. M. O., Omojasola, P. F., Kayode, I. B. (2016). Biomolecular characterization, identification, enzyme activities of molds and physiological changes in sweet potatoes (*Ipomea batatas*) stored under controlled atmospheric conditions. *Journal of Zhejiang University-SCIENCE B (Biomedicine & Biotechnology)*, 17(4):317-332
- [19] McConnell, R.Y., Truong, V.-D., Walter, Jr, W.M. & McFeeters, R.F. (2005). Physical, chemical and microbial changes in shredded sweet potatoes. *Journal of Food Processing and Preservation* 29, 246–267.
- [20] Onuwa, G. C., Folorunsho, S. T., Binuyo, G., Emefiene, M. & Ifenkwe, O. P. (2020). Economics of sweet potato production in Bokokos local government area of Plateau State, Nigeria. *African Journal of Sustainable Agricultural Development*, 1 (3), 33 – 44, doi: 10.46654/2714.1326
- [21] Amilia, W., Wiyono, A. E., Ferzia, D., Rusdianto, A. S., Suryaningrat, I. B., Mahardika, N. S., & Suryadarma, B. (2021). Physical, Chemical, and Sensory Characteristics of Frozen Salted Edamame During Storage at Room Temperature. *International Journal on Food, Agriculture and Natural Resources*, 2(1), 9–18. <https://doi.org/10.46676/ij-fanres.v2i1.20>
- [22] Chawla, R., Sivakumar, S., Kaur, H., & Mishra, S. K. (2021). Effect of starch based edible antimicrobial films and modified atmospheric packaging (MAP) on extended life of composite sweetmeat. *Carbohydrate Polymer Technologies and Applications*, 2, 100055. <https://doi.org/10.1016/j.carpta.2021.100055>