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VARIETAL EVALUATION OF THE CHEMICAL COMPOSITION, FIELD PERFORMANCE AND YIELD OF SOME IMPROVED CASSAVA (*MANIHOT ESCULENTA* CRANTZ) VARIETIES IN RIVERS STATE, NIGERIA

Dimkpa, S. O. N. and Theophilus, A. J.
[1]Department of Crop/Soil Science, Rivers State University, Port Harcourt, P.M.B 5080, Rivers State, Nigeria

ABSTRACT: *This study examined eleven improved cassava varieties that could be recommended to farmers for higher productivity in order to meet the high demand for cassava produce in the sub region. The eleven cassava varieties include TMS 01/1371, TMS 96/1632, TMS 98/0510, TME 419, TMS 98/0581, TMS 01/1368, TMS 07/0593, TMS 98 / 0505, TMS 30572, TMS 92/0326 and TMS 95/0289. The field performance evaluated include: plant height, leaf number, number branched, fresh tuber yield and dry weight. Immediately after harvest, the tubers were analyzed for chemical composition such as hydrogen cyanide, percentage moisture content, fibre and starch for each of the varieties. Results of the study showed significant (P<0.05) variation on the performances of the various improve cassava varieties studied. The top seven high yielding varieties among the studied varieties intense of fresh tuber yield which is a product of high growth performance as revealed by the results of this experiment include TMS 01/1371 > TMS 01/1368 > TME 419 > TMS 98/0505 > TMS 98/0581 > TMS 30572 and TMS 92/0326 in decreasing order. Similarly, low cyanide content and early high dry matter content such as starch and fibre evaluation of the studied varieties significantly (P<0.05) revealed TME 419 as the best performed followed by TMS 98/0505 > TMS 30572 > TMS 01/1368 > TMS 01/1371 and TMS 07/0593 in decreasing order. These varieties could be recommended for rapid stem multiplication and distribution to farmers for cultivation and consumption in Rivers State and Nigeria at large to increase the quantity of cassava products. With these selected improved varieties, adequate agronomic practices and processing, cassava yield and product quality could be bettered with less land use and labor.*

KEY WORDS: Cassava, varieties, growth performance, chemical composition, yield.

INTRODUCTION

Cassava (*Manihot esculenta*) is of the Euphorbiaceae spruce Family. Most cassava varieties are diploid with 2n chromosome number = 36 (Bokanga *et al.*, 1994).The two main varieties are "the potentially toxic bitter varieties (*M. esculenta*) and the safer sweet varieties (*M. dulcis*), the bitter varieties are very productive but contain defensive chemicals that contain bitter cyanide in the roots" (Albert *et al*., 2005). *Manihot* species are perennial shrub grown primarily for its storage roots which are eaten as a vegetable.

The cassava crop has a wide adaptability and produces yield in various agro-ecological and agronomic conditions (Mesut and Ahmet, 2002). El-Sharkawy (1993) reported yields as high as 90 t ha^{-1} obtained in experimental trials of some improved cassava cultivars under near-optimum climatic conditions in Colombia. The global production of cassava in 2014 was 278.7 million tons with an estimate of 281 million

tons for 2015 and 288.4 million tons for 2016 (FAO, 2016). Cassava is a major stable crop in Africa because of its relative high productivity under conditions of erratic rainfall and low-fertility soils. 250 million Africans depend on cassava as food, with more than 90% of the 117 million tons produced in Sub-Saharan Africa (SSA) in 2007 being used for fresh consumption and processed food (Philips, 2006). There is no doubt that cassava output in Nigeria has increased tremendously from 59 million tons in 2017, to 60 million tons in 2018 making Nigeria the highest producer of cassava in the world (FAOSTAT, 2019). This is approximately 20% of global production with a 37% increase in the last decade. Nigeria exports about 3.2 million tons annually and earned about $136 million (FAOSTAT, 2019). The increasing importance of cassava (*Manihot esculenta*) among crops grown in Nigeria is not only connected to its increasing demand as food but also as food security (FAO, 2018).

Cassava remain an important source of dietary carbohydrate and staple food crop for many Nigerians today (Abdulahi, 2003), by supplying about 70% of the total calorie intake of Nigerian (Nneoyi *et al.*, 2008). Due to many initiatives and support programs, the growth of cassava production in Nigeria reached incredible numbers. Cassava is an important source of starchy food in tropical regions, apart from its use as a major source of carbohydrate. The industrial use of cassava is very versatile and its derivatives and starch are applicable in many types of products such as foods, confectionery, pharmaceutical, sweeteners, glues, plywood, textiles, paper, biodegradable products in crude oil exploration and drugs. Cassava chips and pellets are used in animal feed and alcohol production (Balagopalan, 2002).

Some cassava root constitute moisture (80%), starch (34%), minerals (3%), fiber (3%) and protein (2%) (AOAC, 2010). Moisture content affects the process, shelf-life, usability and quality of the cassava product. Accurate moisture content determination therefore plays a key role in ensuring quality in many industries including Food, Pharmaceuticals and Chemicals. Many varieties contain a substance called cyanogenic glucosides that can generate cyanide in the storage roots, which is toxic, though could be reduced if adequately processed (Bokanga *et al*., 1994). At harvest of cassava tubers, the amount of hydrocyanic (HCN) acids varies from harmless to lethal. The lethal dose of HCN is 50mg/kg fresh weight. Hydrolysis of Cynogenic glycoside by the enzyme can be accelerated through the various processing techniques by soaking the roots in water, by crushing or cutting them or by heating.

The demand for cassava roots and products are high and fast rising. However, the current production is far from being able to meet the food and industrial need of the geometrically growing population in the sub-region (FAO, 2018). This therefore call for concentrated national policy action and continuous research particularly breeding for high yielding, early maturing and pest / disease resistant cassava varieties since the land area for cultivation is diminishing as a result of growing population and urbanization. Cassava though, is among the crop whose production level has tripled over the past 50 years while its development has been further advanced through ongoing Cassava breeding programme and research in the sub region which is champion by the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. The main objective of breeding programme is to develop varieties superior to those currently cultivated by farmers, especially for the economically or biologically important traits such as high yielding, high starch content, low cyanogenic glycoside, earliness to maturity, and not limited to pest and disease resistance / tolerance (Fukuda *et al*., 2002). IITA has therefore since 1980 continued to release and distributed more improved productive new varieties that are high yielding as well as resistant to a number of diseases, pests, and drought (Dixon *et al*., 2010). However, some of these released varieties have been reported to lose their resistance

or heritable traits after a number of years of cultivation in some parts of Nigeria due to resistance pressures or climate changes (Brush and Perales, 2007; Dimkpa *et al*., 2021). Dhaliwal *et al*. (2013) reported that global warming may result in breakdown of resistance to certain insect pests and also natural enemies of pest species which may not be limited to heritable qualities of the crop. Farmers and researchers in particular, therefore need to continuously monitor the field performances of these varieties to detect anomalies in traits of economic importance and replace with new cultivars. Hence this article document the evaluation of chemical constituent, growth and field performance including yield of eleven IITA improved cassava varieties in the humid tropic.

MATERIALS AND METHODS

Study Area

The research work was carried out at the Teaching and Research Farm of Rivers State University, Nkpolu-Oroworukwo, Port Harcourt. The farm situated on latitude 4.46°N and longitude 7.10°E an elevation of 18m above sea level. Port Harcourt is a coastal city located in the Niger Delta region of Nigeria within latitudes 6°58'-7°60'E and longitudes 4°40'- 4°55'N (NDES, 1979). The land area was cleared of trees and root stumps and then the soil was ploughed and harrowed with a tractor to a fine tilt.

Sources of experimental material

Eleven cassava varieties stakes were collected from IITA for planting. The varieties collected are: TMS 07/0593, TMS 98/0510, TME 419, TMS 01/1371, TMS 96/1632, TMS 30572, TMS 98/0581, TMS 01/1368, TMS 07/0593, TMS 98/050 and TMS 92/0326.

Parameters Measured

Plant Height: The plant height of the cassava varieties were recorded by measuring the distance between the base of the plant and the top of the canopy using a meter rule. Ten cassava stands in each plot.

Measurement of Leaf Number: Leaves numbers were counted for five cassava stands per plot.

Determination of Branched Stands: The numbers of branched stand were recorded by counting the branched stands per plot.

Fresh Tuber Yield (kg): Fresh tuber weights were recorded by weighing the freshly harvested tubers with a calibrated scale immediately after harvest per plot.

Chemical Analysis: The eleven cassava varieties were analyzed for hydrogen cyanide content, percentage of starch, moisture content and fiber following the procedures by AOAC (2010).

Experiment Design and Statistical analysis:

A total land area of 36m x 120m = 4,320m² (0.432ha) having 11 treatments, replicated in four different plots were laid out in Randomized Complete Block design (RCBD). The collected data from the field and laboratory were arranged in excel spreadsheet and analyzed using Minitab software (Minitab, 2010).

RESULTS

Growth Performance

The experimental result showed a significant difference (P< 0.05) for plant height in the studied cassava varieties. The highest plant height of 280.1cm was recorded by TMS 01/1368 follow by TME 419 with a height of 241.7cm and TMS 95/0289 (196.2cm) while the shortest was TMS 07/0593 with a plant height of 70.1cm (Table 1). Similarly, TMS 01/1368 had significant highest number of leaves (206.6), followed by TME 419 (191.7) and TMS 01/1371 (179.5), while the lowest was recorded by TMS 07/0593 (70.1). Number of branches was significantly highest (P< 0.05) in variety TMS 01/1371 (43.6) followed by TMS 01/1368 (18.3) and TMS 30572 (15.7), while the lowest branched was recorded by TMS 07/0593 (4.6). Some varieties like TMS 98/0581, TMS 98/0505, TMS 96/1632 etc did not branch (Table 1).

Table 1: Varietal Differences on the Growth Performance

Varieties	Plant height (cm)	Number of leaves	Number of branches
TMS 98/0581	145.9^{g}	121.6^{g}	0.0^{g}
TMS 01/1368	280.1^{a}	206.6^{a}	18.3^{b}
TMS 30572	170.2^{e}	174.7^{d}	15.7^{c}
TMS 98/0510	132.8^{h}	127.6^{f}	7.7^{e}
TMS 01/1371	194.4^{c}	179.5^{c}	43.6^{a}
TMS 98/0505	150.3^{f}	173.3^{cl}	0.0^{g}
TMS 96/1632	124.4^{i}	84.4^{j}	0.0^{g}
TME 419	241.7^{b}	191.7^{b}	13.7^{d}
TMS 92/0326	176.6^{d}	168.5^{e}	0.0^{g}
TMS 95/0289	196.2^{c}	117.2^{h}	0.0^{g}
TMS 07/0593	76.2^{j}	70.1^{k}	4.6^{f}

*Means that do not share same letter are significantly different (Tukey method at 95% Confidence level).

Cassava Tuber Yield

Significant differences existed among the tuber yield at seventh and twelfth Months. At seventh month, the varieties recorded high mean number of tubers per stand (4.4) than in the twelfth month (2.3) while the mean weight per stand was significantly higher at twelfth month (1.3kg) than at seventh month (0.9kg). The highest mean number of tubers per stand was recorded by TMS 01/1368(4.9), followed by TMS 98/0505(4.0) and TMS 01/1371(3.8) respectively (Table 2), while the lowest number of tubers was recorded by TMS 07/0593 (2.8). Inversely, TMS 01/1371 had the highest mean significant tuber weight of 1.5kg per stand follow by TMS 98/0581 (1.4kg) and TMS 01/1368 (1.3kg) while the least was obtained in TMS 07/0593 and TMS 30572 (0.9kg).

Table 2: Varietal difference on fresh tuber yield (number and weight)

Cultivars	Tuber number per stand	Tuber weight per stand (kg)
TMS 98/0581	3.4^{b-d}	1.3^{a}
TMS 01/1368	4.9^{a}	1.4^{ab}
TMS 30572	3.3^{b-d}	0.9^{c}
TMS 98/0510	3.1^{b-d}	1.1^{bc}
TMS 01/1371	3.8^{b-c}	1.5^{a}
TMS 98/0505	4.0^{b}	1.0^{c}
TMS 96/1632	3.0^{cd}	1.0^{c}
TME 419	3.0^{cd}	0.9^{c}
TMS 92/0326	3.3^{b-d}	1.0^{c}
TMS 95/0289	3.0^{cd}	1.1^{bc}
TMS 07/0593	2.8^{d}	0.9^{c}

*Means that do not share same letter are significantly different (Tukey method at 95% Confidence level)

Chemical Composition of the Various Varieties

The percentage moisture contents of the cassava varieties (wet basis) as illustrated in Table 3 ranged from 56.6 to 63.0% with TMS 07/0593 recording the highest moisture content (63.0%) among other varieties studied while TMS 01/1371 had the least (56.6%). The percentage moisture contents for the dry basis of the cassava varieties ranged from 10.6 - 8.3% with TMS 98/0505 having the highest moisture content (10.6%) among other varieties studied while TMS 01/1371 and TMS 01/1368 had the least (8.3%) followed by TMS 30572 and TME 419 with 8.4% moisture. Similarly, the cyanide (HCN) content was significantly higher in the Wet fresh tuber than the dry cassava in all the varieties (Table 3). TMS 98/0581 having the highest HCN for wet and dry basis (68.7/56.4mg/kg) followed by TMS 95/0289 (65.9/54.1mg/kg) and TMS 96/1632 (62.7/52.6mg/kg) while TME 419 had the lowest HCN level (44.6/29.7mg/kg) followed by TMS 98/0505 (46.1/35.5mg/kg) and TMS 30572 (47.6/36.8mg/kg). Result also revealed a notable difference ($P < 0.05$) in the percentage starch contents of the cassava varieties (wet and dry basis) which ranged 25.4-13.2%. TME 419 having the highest starch (25.4/21.2%) followed by TMS 98/0505 (24.5/20.6%) and TMS 30572 (23.1/19.7%) while TMS 95/0289 had the lowest starch content (15.7/13.2%) followed by TMS 98/0581 (16.6/14.2%). Inversely, the fiber content in the dry cassava tuber is generally higher than the Wet fresh cassava in all the studied varieties. TMS 01/1368 had the highest fiber (wet/dry basis) content of 1.8/2.0% followed by TME 419 (1.7/1.9%) while TMS 96/1632, TMS 01/1371 and TMS 95/0289 recorded the lowest fiber content with the mean value of (1.4%) for wet basis (Table 3).

Table 3: The Chemical Composition of the Various Varieties

	WET BASIS				DRY BASIS			
Varieties	**Moisture (%)**	**HCN (mg/kg)**	**Starch (%)**	**Fibre (%)**	**Moisture (%)**	**HCN (mg/kg)**	**Starch (%)**	**Fibre (%)**
TMS 98/0581	58.1^{g}	68.7^{a}	16.6^{j}	1.5^{ef}	9.3^{e}	56.4^{a}	14.2^{j}	1.6^{e}
TMS 01/1368	57.7^{h}	49.6^{h}	20.8^{e}	1.8^{a}	8.3^{j}	39.9^{g}	19.6^{d}	2.0^{a}
TMS 30572	57.1^{i}	47.6^{i}	23.1^{c}	1.6^{c}	8.4^{i}	36.8^{i}	19.7^{c}	1.9^{c}
TMS 98/0510	61.8^{c}	60.3^{d}	18.2^{i}	1.5^{d}	9.9^{d}	51.3^{d}	16.4^{h}	1.7^{d}
TMS 01/1371	56.6^{j}	51.3^{f}	21.0^{d}	1.4^{h}	8.3^{j}	42.2^{f}	17.9^{e}	1.6^{f}
TMS 98/0505	61.6^{d}	46.1^{j}	24.5^{b}	1.6^{d}	10.6^{a}	35.5^{j}	20.6^{b}	1.7^{d}
TMS 96/1632	61.8^{c}	62.7^{c}	18.8^{h}	1.4^{g}	8.6^{g}	52.6^{c}	17.0^{f}	1.5^{g}
TME 419	60.0^{f}	44.6^{k}	25.4^{a}	1.7^{b}	8.4^{g}	29.7^{k}	21.2^{a}	1.9^{b}
TMS 92/0326	62.1^{b}	58.8^{e}	19.4^{f}	1.5^{e}	10.1^{c}	50.0^{e}	16.0^{i}	1.6^{e}
TMS 95/0289	60.5^{e}	65.9^{b}	15.7^{k}	1.4^{g}	8.9^{f}	54.1^{b}	13.2^{k}	1.6^{f}
TMS 07/0593	63.0^{a}	50.2^{g}	19.2^{g}	1.5^{f}	10.5^{b}	39.6^{h}	16.8^{g}	1.6^{f}

*Means that do not share same letter are significantly different (Tukey method at 95% Confidence level).

DISCUSSION

Plant height is an important attribute in cassava. The result showed that tall cassava varieties, for examples TMS 01/1368, TME 419 and TMS 95/0289 recorded superior performances in other desirable traits. 01/1368 which was the tallest cassava plant had good tuber number; TME 419 which produced second tallest plants had high fresh tuber yield. Therefore, since tallness is positively associated with yield parameters, the need to select cassava for such trait is important. Secondly, the need to secure adequate planting materials for planting requires that the varieties so selected to produce the next generation must have large, vigorous stems.

Some cassava varieties significantly produced higher leaves number than others. TMS 01/1368 which was the tallest cassava variety also produced the highest leaves number and consequently produced a high fresh tuber yield. Similarly, TME 419 which was second in height and leaves number produced a high number of tubers. TMS 98/0505 which was the fourth highest leaves number was also second for number of tubers, while TMS 01/1371 which was third in high leaves number produced the highest tubers dry weight and high fresh tuber yield. Bassey and Harry (2013) regarded the power of the leaf as a major organ of photosynthesis, which directly correlate with the sink capacity in cassava producing more tubers. This report was fully confirmed by the experimental result as TMS 07/0593 variety with fewer leaves also had lowest number of fresh tubers and weight. These suggest the direct effect of growth performance on yield performance in cassava. Austin *et al.* (1988) established an association between grain yield and leaf number in wheat. According to them, the leaves which persist until the grain filling stage, together with other green surfaces provide the photosynthetic capacity for carbon fixation and hence the supply of carbohydrate to the grain. It is also worthy to note that these varieties with high growth performance revealed in this experimental results such as TMS 01/1371, TMS 01/1368, TME 419, TMS 30572, and TMS 92/0326 have been earlier reported by Dimkpa *et al.*, (2021) in the same agro-ecological environment though the earlier experiment was for only 6 months.

The high yielding varieties intense of fresh tuber yield as revealed by the results of this experiment include TMS 01/1371, TMS 01/1368, TME 419, TMS 98/0505, TMS 98/0581, TMS 30572, and TMS 92/0326. This result agrees with IITA (2013) which established these varieties as high yielding and recommended them for increase productivity of cassava in West Africa. Other desirable attributes of good cassava varieties include early maturing, low moisture content, starch accumulation etc. TMS 01/1368 and 01/1371 which were recently released in 2011 by IITA top the list of the high growth performance and fresh/dry tuber yield. These varieties are also Pro Vitamin A cassava newly released and distributed to provide more vitamin A supplement in the diets of over 70 million Nigerians and contribute to reducing vitamin A deficiency, which is widespread in Nigeria. The growth performances and fresh/dry tuber yields of the other varieties studied revealed insignificant differences which attest the report of IITA (2013) and Dixon *et al*. (2010) that the varieties are improved high yielding cassava varieties and are still very suitable to promote the productivity of cassava in the agro ecological zone. The perceived variation in their varietal performances in this research work might be attributed to varietal differences in the genetic makeup or their genetic sensitivity and reaction to the agro-ecological environment (Emehute *et al.,* 1998, Dimkpa *et al*., 2015; Dimkpa *et al*., 2021).

The experimental result importantly revealed that all the studied cassava varieties had low moisture contents on dry basis and these will help for storage of the tubers along with higher starch content. Edet *et al.* (2017) emphasized the importance of moisture content as a major factor in the preservation of fresh cassava tubers, cassava flour and further established that 14% moisture level in cassava produce will encourage microbial growth and reduce the shelf life and flavor of the produce. TMS 01/1368 and TMS 01/1371 which showed lowest moisture content when compared with the other varieties analyzed will be good for longer storage live and hence delivers the potential for better shelf life. The varieties with lower moisture contents (TMS 01/1368, TMS 01/1371, TME 419 and TMS 30572) as revealed by this experiment consequently contained higher starch and fiber levels. Opadokun (1977) reported that moisture content normally depends on certain factors such as farm site, the season of production, the tuber produce and processing method.

The result of this study generally revealed increased crude fibre levels at the dried cassava tuber than the wet basis with TMS 01/1368 topping the list, followed by TME 419, TMS 30572, TMS 98/0505, TMS 98/0510 and TMS 01/1371 in that order while TMS 96/1632 had the lowest fibre percentage. The fibre content revealed in this experiment is generally low compared to that reported by Dixon *et al*. (2010) which may be a product of season and agro-environmental condition. Fibre represents that portion of food not used up by the body but mainly made up of cellulose (60-80%) together with a little lignin (4-6%) plus some mineral matter and is known to increase bulk stool (Eleazu *et al*., 2011).

The experimental result most importantly revealed that the cyanide (HCN) content was significantly higher in the Wet fresh tuber than the dry cassava in all the varieties evaluated. TMS 98/0581 having the highest HCN for wet and dry basis (68.7/56.4mg/kg) followed by TMS 95/0289 (65.9/54.1mg/kg) and TMS 96/1632 (62.7/52.6mg/kg) while TME 419 had the lowest HCN level (44.6/29.7mg/kg) followed by TMS 98/0505 (46.1/35.5mg/kg) and TMS 30572 (47.6/36.8mg/kg). The results however showed that the high cyanide content is within the range of sweet cassava variety (Ubwa *et al*., 2015; Wheately *et al.,* 1993) but, in excess of the acceptable maximum limit recommended by W.H.O (Bradbury *et al*., 1991). Hydrogen cyanide in cassava tuber is a poisonous acid particularly to human and other livestock but it's a product of

plant secondary metabolites as a chemical defensive mechanism against herbivores. Traditionally, the reduction and, possibly, elimination of cyanide from raw cassava tuber have been achieved using a combination of several processing schemes (Odoemelam, 2005; Asegbeloyin and Onyimonyi, 2007). The current research also revealed that the final level of residual cyanide in cassava-based products depended on the initial cyanide load in the fresh tuber yield and methods applied in processing raw cassava tubers (Omoike and Adediran, 1991; Cardoso *et al.,* 2005; Okoli *et al.,* 2012). All processing techniques involved operations that trigger the breakdown of cyanogenic glycosides by endogenous hydrolytic enzymes such as linamarase into hydrogen cyanide followed by the volatilization by heating, in form of roasting or boiling. In cases where the residual cyanide in cassava products cannot be totally eliminated, levels of less than 50 mg/kg are considered harmless (Mburu *et al.,* 2012; Lukuyu *et al.,* 2014). The FAO recommended maximum cyanide level in foods to be 10mg CN equivalents/kg dry weight (OECD, 2007). Notwithstanding, chronic toxicity may ensue when the consumption of such cassava-based products are consumed over long period of time (FSN, 2005).

Result also revealed a notable difference ($P < 0.05$) in the percentage starch contents of the cassava varieties relatively higher in the wet fresh tuber than dry cassava product which ranged 25.4-13.2% (wet to dry basis). TME 419 having the highest starch (25.4/21.2%) followed by TMS 98/0505 (24.5/20.6%) and TMS 30572 (23.1/19.7%) while TMS 95/0289 had the lowest starch content (15.7/13.2%) followed by TMS 98/0581 (16.6/14.2%). The cassava tuber is often referred to as starchy root (Nweke, 2004; Montagnac *et al.,* 2009) in that the carbohydrate content is about 30-35% of fresh root (IITA, 1990; Tonukari, 2004; Montagnac *et al.,* 2009), which was in conformity with the present findings. Aside the starchy content of the cassava root, Montagnac *et al.* (2009) had noted that the total and reducing sugars in cassava roots were within the range of 0.2-18.8% and 0.0-15.7%, respectively, on a dry weight basis TMS 95/0289 is the only variety that is within this recommended range every other varieties especially the yellow cassava have high starch content both in the wet and dry basis.

CONCLUSION

The high growth and yield performance as well as the chemical composition of these studied 11 varieties of cassava notably confirmed the varieties as improved high yielding with good dry matter qualities and adequately suitable to be introduced to small and large farm holders in the humid tropics. The top seven high yielding varieties among the studied varieties intense of fresh tuber yield which is a product of high growth performance as revealed by the results of this experiment include TMS 01/1371, TMS 01/1368, TME 419, TMS 98/0505, TMS 98/0581, TMS 30572, and TMS 92/0326 in decreasing order. Similarly, low cyanide and early high dry matter content such as starch and fibre evaluation of the studied varieties revealed TME 419 as the best performance followed by TMS 98/0505, TMS 30572, TMS 01/1368, TMS 01/1371 and TMS 07/0593 in decreasing order. These varieties could be recommended for rapid stem multiplication and distribution to farmers for cultivation and consumption in Rivers State and Nigeria at large to increase the quantity of cassava products and particularly TMS 01/1368, and TMS 01/1371 to enhance vitamin A intake. It is therefore, recommended that smallholder farmers adopt the planting of these improved varieties to boost crop yield in the area and adequately employ good processing techniques to reduce cyanide content to nearest acceptable minimum level for human and animal consumption.

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