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Postharvest Quality of Commercial Tomato (*Lycopersicon Esculentum* Mill.) Fruits Brought into Yenagoa Metropolis from Northern Nigeria

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Abstract
Tomato *(Lycopersicon esculentum* Mill) fruits are rich in vitamins and minerals, and accounts for about 18% of the average daily consumption of vegetables in Nigeria. However, tomato production in Nigeria is bedeviled with postharvest losses arising from improper handling during storage and transportation. Tomato sold in Bayelsa State of Nigeria is mostly received from the northern regions of the country, but the qualities of fruits that come to the State have not been studied. Hence in this study, the Postharvest quality of tomato fruits conveyed into three markets in Yenagoa metropolis, Bayelsa State, Nigeria was assessed. Results showed that only 25.09% of fruits were completely devoid of disease and damage. Whilst 15.04% of the total fruits assessed had physiological disorders, spoilage due to biotic causes accounted for as much as 59.28% of the total fruits. Weighted mean percentage incidence of fruits with soft/sour rot was (34.43%), and were significantly ($P \leq 0.05$) higher than alternaria rot (7.76%), buckeye rot (5.87%), anthracnose rot (0.69%) and rhizopus rot (0.16%). Differences in the number of fruits with alternaria, buckeye, anthracnose and rhizopus rots were not significant at $P=0.05$. Although plant pathogens are generally not pathogenic on humans, they could potentially cause disease in humans with compromised immune system. It is therefore advisable to properly cook tomato fruits before consumption, and only healthy fruits are recommended for recipes, such as salad, that may not require cooking before consumption, while studies aimed at minimizing postharvest spoilage are constantly pursued.
Keywords: Tomato, Fungi, Bacteria, Postharvest disease, Physiological disorder

1. Introduction

Tomato *(Lycopersicon esculentum Mill. Syn. Solanum lycopersicon)* is grown the world over (Agrios, 2005) for its fruits which are known to be rich in vitamins and minerals (John *et al,* 2010; Bugel, 2003). Tomato is particularly known to possess lycopene, an excellent antioxidant (Osemwegie, *et al.,* 2010) that helps to reduce the risk of prostate and breast cancer (Giovannucci, 1999). The fruits are consumed as part of sauces, salads and food drinks (Babalola, *et al*, 2010), and accounts for about 18% of the average daily consumption of vegetables in Nigeria (Olayide *et al*, 1972).

Nigeria is second largest producer of tomato in Africa second only to Egypt and 13th in the world, and produces 6 million tonnes of tomato annually prior to 1990 (Erinle, 1989). In Nigeria, tomato is mostly cultivated in the northern regions of the country, between latitudes 7.5 °N and 13 °N, and within a temperature range of 25 – 34 °C (Villareal, 1980).

Although tomato is mostly cultivated in the northern regions of Nigerian, it is consumed throughout the country (Babalola, *et al*, 2010; Kutama, *et al,* 2007), and this makes transportation an essential component of the distribution process. However, transporting harvested tomato fruits from northern Nigeria, where they are produced, to other parts of the country is often exasperated by non-availability of vehicles when most needed (Idah, *et al*, 2007; Olayemi, *et al*, 2010), and as a result marketers and distributors who convey the harvested product use very harsh and indecent methods such as fastening tomato consignments onto of fuel tankers and other articulated vehicles (Idah, *et al*, 2007; Olayemi, *et al*, 2010).

Transportation amongst other conditions such as improper handling, pre- and postharvest diseases significantly affect the quality and nutritional value of freshly produced tomato fruits (Kader, 1986). Freshly harvested tomato fruits are usually stored, and conveyed in traditional weaved wicker baskets in Nigeria, and these baskets are often reused over and again until they become contaminated with primary fungal spores from previously infected fruits (Kutama, *et al,* 2007). Earlier reports had shown that pathogenic inocula occurring on such baskets initiate disease upon contact with healthy tomato fruits, which eventually result to losses (Kora *et al.,* 2005).

Reports on the amount of postharvest loss or spoilage of tomato in Nigeria, arising from storage and transportation conditions are varied. Whilst some workers showed that postharvest tomato losses accruing to the wholesalers and retailers were 50-70% on the average (Adeoye *et al.,* 2009), others observed a much lower proportion of tomato lost to postharvest storage and transportation (Idah, *et al.,* 2007; Olayemi *et al.,* 2010). Discrepancies on the extent of postharvest tomato losses reported by different workers are, in part, influenced by the distance between fields where the tomato fruits are produced and the market where they were assessed whilst being sold.

Transportation of tomato fruits from northern Nigeria where they are produced to an urban market in South west Nigeria, a distance of less than 1000km, has been reported to cause a loss of as much as 20% (Olorunda and Aworh, 1983). Most studies on postharvest quality of tomato fruits have always focused on locations or markets that were relatively close to production fields (Idah, *et al*., 2007; Olayemi *et al*., 2010), hence mechanical damage that would predispose the fruits to massive microbial infections would be relatively minimal. Works showing the postharvest quality of tomato fruits transported to south-south regions, particularly Bayelsa State, for sale have not been done and data nonexistent.

Hence in this work, the postharvest quality of tomato fruits were assessed as they arrived three different markets situated in Yenagoa metropolis, the Bayelsa State capital of Nigeria. The findings of this work would afford us the opportunity to assess the potential economic and human health implications of consuming tomato fruits sold in Bayelsa State.

2. Materials and methods

Three markets situated in three separate towns (Swali, Opolo and Edepie) in Yenagoa metropolis (Fig. 1), were selected and three retailers (representing three replicates) were randomly selected from each of the markets for sampling of tomato fruits. About 53-139 tomato fruits were randomly selected from each of the three retailers per market and the fruits were sorted into three different categories - healthy fruits, fruits with postharvest disease symptoms and fruits with physiological disorders, respectively. Tomato fruits that were free from rottenness, signs of microbial growth and physical deformity were considered healthy. Fruits with visible signs of microbial growth and/or rottenness were considered as suffering from postharvest disease. Fruits that neither showed signs of microbial growth nor were rotten, but were clearly deformed are considered to suffer from physiological disorder.

Fruits with postharvest disease symptoms or physiological disorders were further sorted into different types of diseases and disorders. Identification of the various postharvest disease conditions and physiological disorders were based on works described in the Postharvest handling technical bulletin series no. 9 published by New Guyana Marketing Corporation (NGMC) and National Agricultural Research Institute (NARI) in 2003, Bartz and Associtaes (2003) and Olson (2004).

The number of tomato fruits with the various postharvest quality conditions (healthy, postharvest disease and physiological disorder) was recorded as percentages of the total number of fruits assessed. Fruits with different types of postharvest disease symptoms and physiological disorders were also recorded as percentages of the total number of fruits assessed. Percentage data were arcsine transformed according to Gomez and Gomez (1984) and subjected to ANOVA using SPSS version 16.0 statistical software. Comparisons were based on various postharvest qualities of tomato fruits with respect to weighted percentage incidence.

3. Results and discussion

A significant proportion of tomato fruits that are conveyed from northern Nigeria into Yenagoa metropolis were observed to suffer from various postharvest diseases and disorders. Specifically, only 25.09% of tomato fruits that arrived Yenagoa metropolis were devoid of any form of postharvest disease symptoms or physiological disorder (Table 1). Whilst 15.04% had physiological disorder, 59.28% of the fruits were infected with one form of postharvest disease or the other. Adeoye and Associates (2009) posits that mechanical damage to tomato ranks highest in economic postharvest losses followed by pathological damage while physiological damage causes the least.

Globally, postharvest losses of tomato have been reported to be in the range of 30 to 40% (Agrios, 2005; Kader, 1992), but results of this work rather substantiated the claims of Prigojin and Associates (2005) who posited that postharvest losses of tomato in developing countries, like Nigeria, would be much higher because of improper handling procedures and lack of methods to prevent decay. However, reports on the extent of postharvest spoilage of tomato fruits have been quite varied amongst different workers. Opadokun (1987) showed that whilst 21% of harvested tomato was lost to rot in the field, an additional 20% was lost to poor storage system. Similar to the findings of this present work Adeoye and associates (2009) advanced that postharvest tomato losses accruing to the wholesalers and retailers were 50-70% on the average. In contrast, however, some workers have also shown that the percentage loss of postharvest tomato during storage and transportation was relatively minimal, ranging from 13.9% to 20% (Idah, *et al.,* 2007; Olayemi *et al.,* 2010). Markets with relatively low proportion of spoilt tomato fruits were often situated not too distant away from where the fruits were produced. Unlike the studies of Idah, *et al.,* (2007) and Olayemi *et al.,* (2010), the tomato fruits assessed in this study were harvested in northern Nigeria, and transported to markets in Bayelsa State, covering over 1000km with several stop points. This relatively long distance would have impacted on the tomato fruits, causing significantly greater postharvest losses as observed in this present study.

Diseased fruits were observed to portray different postharvest disease symptoms. The different postharvest diseases, in order of decreasing weighted mean percentage incidence, were Soft/Sour rot (34.43%), Alternaria rot (7.76%), Buckeye rot (5.87%), Anthracnose (0.69%) and Rhizopus rot (0.16%) (Table 2). Whilst the percentage of fruits with soft/sour disease symptoms were significantly ($P\leq 0.05$) higher than any other disease, the difference in percentages of fruits with alternaria, buckeye, anthracnose and rhizopus rots were not significant at 5% probability level (Table 2).

Although fungi are said to be the most important and prevalent pathogens, infecting a wide range of fruit and causing destructive and economically important postharvest losses during storage, transportation and marketing (Sommer, 1985), soft/sour rot was significantly higher than every other postharvest disease observed amongst tomato fruits assessed in this work. Amongst the seven microbial pathogens that causes soft/sour rot of tomato fruits six are bacterial species, while only one is a fungus species. Whilst bacterial species responsible for soft rot include members from 4 genera, *Erwinia, Pseudomonas, Xanthomonas* and *Bacillus* (Bartz *et al.,* 2003) no fungus has been so far recorded to cause soft rot. With respect to Sour rot, whilst two bacterial species, *Lactobacillus* species and *Leuconostoc* species are implicated with the disease only one fungus, *Geotrichum candidum* (Bartz *et al.,* 2003) is known to cause same disease in tomato fruits. The findings of this work suggest that, contrary to popular opinion, bacteria seem to be the most important pathogen of postharvest losses of tomato fruits during storage and transportation.

Soft rot pathogens are quite invasive because they are easily transmitted through fluids emanating from diseased fruits to healthy ones across storage containers. Furthermore, incubation period for disease manifestation could be less than 18 hours under favourable conditions (Bartz *et al.,* 2003). This possibly explains the high incidence of this disease among tomato fruits assessed in this study, and could well be most prevalent postharvest disease affecting tomato fruits in storage and transportation.

Like soft rot, sour rot symptoms were identified by decay and subsequent softening of fruit tissues. The two diseases are usually delineated by the odour they produce. Whilst, soft rot produces a foul odour (NGMC and NARI, 2003), tomato fruits affected by sour rot disease give off a sour odour, as though the fruits had been pickled (Bartz *et al.,* 2003; NGMC and NARI, 2003) but fruits showing these symptoms were counted together in this work because sour rot disease at an advanced stage results to soft rot (NGMC and NARI, 2003), besides smell could be confusing as pathogens responsible for both diseases could occur together.

After soft/sour rot disease (34.43%), Alternaria rot (7.76%) had the highest mean percentage incidence of tomato fruit rots (Table 2). Alternaria rot has been severally reported as the most common fungal disease of tomato fruits (Douglas 1922; Hassan, 1996). Since soft and sour rots are mostly caused by bacteria, the findings of this work would have also validate alternaria rot as the most common postharvest fungal disease of tomato that comes into Yenagoa metropolis from northern Nigeria where they are mostly produced. This position, however, was not supported by results of statistical analyses. Although alternaria rots ranked highest among postharvest tomato diseases assessed in this work, its mean percentage incidence was not significantly ($P=0.05$) higher than other postharvest diseases such as anthracnose, buckeye and rhizopus rots (Table 2). Similarly, *Rhizopus stolonifer*, responsible for rhizopus rot disease, has been reported to be the second common fungal pathogen associated with tomato spoilage (Bartz *et al.,* 2003), but findings from this work showed that the percentage of tomato fruits with rhizopus rot were also not significantly higher than those with other postharvest fungal diseases assessed in this work. On the contrary, its mean percentage incidence was relatively lower (though not significantly different at $P=0.05$) than those recorded with alternaria, anthracnose and buckeye rot diseases. Discrepancies in findings amongst different workers, could in part, be attributed to differences in the variety of tomatoes studied and the conditions under which the fruits are stored and transported. Tomato variety has been reported to significantly affect the extent of postharvest damage due to spoilage fungi. A study carried out in Oyo State, South western Nigeria showed that whilst up to 44% of postharvest spoilage was attributed to microorganism in a given tomato variety, only 14-23% of spoilage was attributed to the same microorganism among other varieties (Adeoye *et al*., 2009).

Apart from postharvest disease due to biotic agents, 15.04% of the total tomato fruits assessed in this study were observed to suffer from physiological disorders (Table 1). Fruits were observed to have symptoms characteristic for fruit shrivel and zippering. Weighted mean percentage incidence of fruits with fruit shrivels was 3.25%, and 8.06% of the total fruits showed zippering disorder (Table 3). The differences in weighted mean percentage incidence of fruits with fruit shrivel and zippering disorders were not significant at the 5% probability level. Tomato with fruit shrivel symptoms were similar to those described by NGMC and NARI (2003) as they were observed to shrink particularly at the base of the fruit. Fruits with zippering characteristics assessed in this work were similar to those described by Olson (2004), and were characterized by the presence of longitudinal thin scars extending from the stem scar to the blossom end. Although these disorders may not have adverse health implication they would nonetheless adversely affect the economic value of tomato fruits because consumers are incline to pay less for fruits with these symptoms.

4. Conclusion

Tomato fruits, like any other fruit, are susceptible to pathogenic bacteria and fungi. In addition to causing rots and other postharvest diseases, some fungi may also make them unfit for consumption by producing mycotoxin (Philips, 1984; Stinson *et al.*, 1981). Only about 25% of the fruits assessed in this study would be considered completely healthy without any form of disease or disorder. Whilst 15.04% of fruits that arrives Yenagoa metropolis from northern Nigeria had one form of physiological disorder or the other, majority of the fruits (59.28%) had disease symptoms showing infection with either bacteria and/or fungi. Most small scale entrepreneurs in Bayelsa State who are into restaurant and food business are known to prefer buying tomato with visible soft and sour rot disease symptoms because the price for such fruits are substantially reduced compared to the price for healthy fruits. Although plant pathogenic bacteria and fungi are generally not pathogenic on humans, the microorganism implicated with the postharvest disease symptoms observed in this study, would nonetheless pose huge health challenges amongst human subjects whose immune systems are compromised. It would therefore be advisable to thoroughly clean and properly cook tomato fruits before they are consumed. Only healthy fruits are recommended for use as part of for food recipes, such as fruit salads, that do not entail cooking. Furthermore, there is an urgent need for studies aimed at seeking ways to grow tomato fruits in Bayelsa State to reduce the amount unhealthy fruits that are conveyed into, and consumed in the State. In addition, efforts should be geared towards seeking ways to preserve, or reduce the proportion of fruits that gets affected by postharvest diseases during storage and transportation from production areas to points of sale.

References

Adeoye, IB, Odeleye, OMO, Babalola, SO and Afolayan, SO (2009). Economic Analysis of tomato losses in Ibadan metropolis, Oyo State, Nigeria. *Afr. J. of Basic & Appl. Sci*. **1,** 87-92.

Agrios, G.N. (2005). *Plant pathology,* Academic press, New York, USA

Babalola, D.A; Makinde, Y.O; Omonona, B.T; Oyekanmi, M.O. (2010). Determinants of postharvest losses in tomato production: a case study of imeko – Afon local government area Ogun State. *Acta SATECH*, 3,14-18.

Bartz J. A., Sargent, S. A. and Mahovic, M. (2004). Guide to Identifying and Controlling Postharvest Tomato Diseases in Florida. Publication #HS866/HS131 Horticultural Sciences Department, Florida Cooperative Extension Service. University of Florida/IFAS, Gainesville. edis.ifas.ufl.edu/hs

Bugel, S. (2003). Vitamin K and bone health. *Proc. Nutri Soc.* **62,** 839-843.

Douglas B, 1922. A new *Alternaria* spot of tomatoes in California. *Phytopathol.* **12,** 146-148.

Erinle ID (1989). Present status and prospect for increased production of tomato and pepper in Northern Nigeria. Procedure of international symposium. Integrated Management Practices. AVRD, Tainan, Taiwan

Giovannucci, E (1999). Tomatoes, tomato-based products lycopene, and cancer: review of the epidemiologic literature. *J. Natl cancer Inst.* **17:** 91, 317-331.

Gomez KA and Gomez AA (1984) *Statistical procedures for agricultural research*, 2nd edition, John Wiley and Sons, Singapore. 734pp

Idah PA, Ajiegiri ESA and Yisa MG (2007). Fruits and Vegetables Handling and transportation in Nigeria. *AU J.T.* **10,** 175-183

John, D, Suthin, RT, Usha, RS and Udhayakumar, R (2010). Role of defense enzymes activity in tomato as induced by *Trichoderma virens* against Fusarum wilt caused by *Fusarium oxysporum F. Sp Lycopersici. J. Biopesticide,* **3,** 158-162.

Kader AA (1986). Effects of postharvest handling procedures on tomato quality. *Acta Hortic.* **190,** 209-221

Kader, AA (1992). Postharvest biology and technology: an overview. In: Kader, A.A (ed.) *postharvest Technology of Horticultural Crops.* P. 15-20. University of California, Division of Agriculture and Natural Resources, pub. 3311, California USA

Kora, C, McDonald, MR, Boland, GJ (2005). Occurrence of fungal pathogens of carrots on wooden boxed used for storage. *Plant pathol.* **54,** 665-670

Kutama, A.S, Aliyu, BS and Mohammed, I (2007). Fungal pathogens associated with tomato wicker baskets. *SWJ.* **2,** 38-39

NGMC and NARI (2003). Tomato: Postharvest care and market preparation.Postharvest handling technical bulletin series no. 9. 22pp

Olayemi, FF, Adegbola, JA, Bamishaiye, EI and Daura, AM (2010). Assessment of postharvest challenges of small scale farm holders of tomatoes, Belland Hot pepper in some LGA of Kano State *Bayero J pure and Appl. Sci*. **3,** 39-42

Olayide, SO, Olatunbosun, D, Idusogie, EO and Abia gom, J.O. (1972). *A quantitative analysis of food requirement, supplies and demand in Nigeria.* 1968-1985. Federal department of Agriculture . 112pp.

Olorunda, A. O., and O. C. Aworh. 1983. A quantitative assessment of post harvest losses of perishable vegetables in Nigerian marketing system. *Nig. J.Sci.* **17,** 40-49.

Olson, SM (2004). *Physiological, nutritional and other disorders of tomato fruit.* University of Florida IFAS Extension HS-954. EDIS website at http://edis.ifas.ufl.edu.

Opadokun, J.S. (1987). *Reduction of postharvest losses in fruits and vegetables.* Lectures delivered at AERLS/NSPRI Joint National Crop protection workshop, Institute for Agricultural Research, Zaria, Nigeria. Pp. 3-26.

Osemwegie, OO, Oghenekaro, AO and Owolo, LO (2010). Effect of *pulverized Ganoderma spp., on Sclerotium rolfsii* Sacc and Post-harvest tomato fruit preservation. *J. Appl. Sci Res.* **6,** 1794-1800.

Philips, OJ (1984). Mycotoxins as a postharvest problem. In: Moline, HE (ed.) *Postharvest pathology of fruits and vegetables: postharvest losses in perishable crops* 50-54.

Prigojin, I, Fallik, E, Qat. Y, Ajalin, I, Allam, H, Ezzat, M and Bader, M (2005). Middle East regional agricultural program: Survey on postharvest losses of tomato fruit and table grapes. Proceedings of the 5th international postharvest symposium, June 6-11 in Verona, Italy. *Acta horticulture* (ISHS). **682,** 1049-1056.

Sommer, NF (1985). Strategies for control of postharvest disease of selected commodities. In: *postharvest Technology of Horticultural Crops.* Univ. Calif. Spec. Pub. 3311, DANR, Oakland, CA. 83-98.

Stinson, EE, Osman, SF, Heisler, EG, Siciliano, I and Bills, DD (1981). Mycotoxin production in whole tomatoes, apples, oranges and lemons, *J. Agric. Food Chem.,* **29,** 790-792.

Villareal RI (1980). Tomato in the tropics. Wesview Press Boulder, Colorado U.S.A

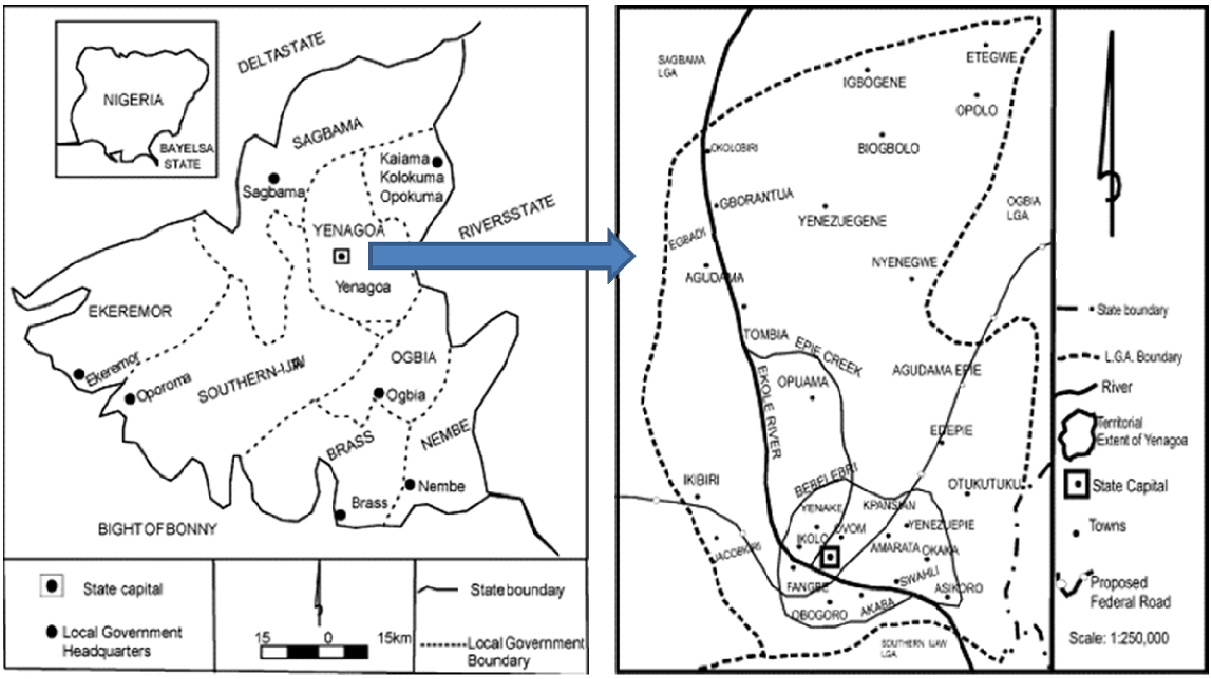

Fig. 1. Map showing sample sites.
Left: Map of Bayelsa State, Nigeria, showing the different Local Government Areas (LGA)
Right: Map of Yenagoa LGA showing the sample sites (Swali, Opolo and Edepie)

Table 1: Mean Percentage of commercial tomato fruits with differing postharvest harvest quality on arrival for sale in Yenagoa metropolis, Bayelsa State

	Mean Percentage Incidence	
Postharvest fruit quality	Arcsine transformed[y]	Weighted
Healthy	30.06[a]	25.09
Physiological disorder	22.82[a]	15.04
Postharvest disease	50.35[b]	59.28

[y] Same letters represent means that were not significant at *P=0.05*. Data with different letters denotes significance at *P≤ 0.05*

Table 2: Postharvest diseases of tomatoes fruits on arrival for sale in Yenagoa metropolis, Bayelsa State

	Mean Percentage Incidence	
Postharvest disease	Arcsine transformed[y]	Weighted
Soft/Sour rot	35.93[b]	34.43
Alternaria rot	16.18[a]	7.76
Buckeye rot	14.02[a]	5.87
Anthracnose rot	4.75[a]	0.69
Rhizopus rot	2.30[a]	0.16

[y] Same letters represent means that were not significant at *P=0.05*. Data with different letters denotes significance at *P≤ 0.05*

Table 3: Physiological disorders of tomatoes fruits on arrival for sale in Yenagoa metropolis, Bayelsa State

Physiological disorder	Mean Percentage Incidence	
	Arcsine transformed[y]	Weighted
Fruit shrivels	10.39[a]	3.25
Zippering	16.49[a]	8.06

[y] Same letters represent means that were not significant at *P=0.05*.