International Academic Journal of Information, Communication, Technology & Engineering
ISSN: 5741-2605 | Volume 8, Issue 1 | Pages 49- 60 | April, 2022
Double Blind Peer Reviewed International Research Journal
www.accexgate.com
papers@accexgate.com

Effect of Hot Water Treatment on Post-Harvest Disease and Quality of Sweet Potato

M.M Abubakar[1]*, Idris Dauda[2], Washara Ester Y[1], Abdullahi M Kauji[1], Usman Ishaq[1]

[1]Department of Agricultural and Bio-environmental Engineering Technology, Ramat Polytechnic Maiduguri, Nigeria

[2]Department of Agricultural Technology Ramat Polytechnic Maiduguri, Nigeria

*corresponding author: M.M Abubakar muhammadabubakar1336@gmail.com

Abstract: *Nigeria is the largest producer of sweet potato in Africa with annual output of 3.46 million metric tons globally the second largest producer of fruits and vegetables, the losses range from 10 to 30% of the entire production. This is due to numerous causes but the most important reason is infestation of fungi. Many synthetic fungicides are employed for postharvest treatment of tubers through the world. However, fungicide residues often represent a significant threat to human health. The current study was to use warm water treatment on sweet potato. Warm water at 50^0c was used for four treatments in three different dipping time of 0min (control) 10 minutes, 15 minutes and 20minutes. Data are collected based on quality assessment these include weight loss, tuber firmness, rind thickness and appearance. The experiment was single factor and will be laid in (CRD). The result on all parameter showed that 10min dipping time has the potential in prolonging the shelf life of tuber by reducing decay on it and has best ability to maintain the quality of sweet potato in comparison with the other treatment.*

Keywords: *Potato Tuber, Hot Water Treatment, Postharvest, Fungi*

Background of the Study

Sweet potato (*Ipomoe batatas L.*) is an important crop food security in many parts of the developing world. Sweet potato has a short growth cycle (four to five months): yields will in maginsl area, and is drought tolerant. In addition to these agronomic advantage sweet potato is good source of carbohydrate, fiber, vitamin and minerals (Endrias et al., 2016) Sweet potato also certain phytochemicals which are good for human health despite all these nutritional and agronomic benefit, sweet potato is highly perishable after harvesting (Rees *et al*., 2003). The major cause of product losses is weight loss, sprouting and rotting (Ravi *et al.,* 1996). Control of sweet potato postharvest losses has generally been reliant on the manipulate of storage temperature and relative humidity. With the aim of achieving an ideal storage temperature of 15 degree and relative humidity of 80% to 95% (Amral B., *et al.,* 2011) in some cases, sprouting and rotting is controlled by heat treatment.

Sweet potato is a major crop that surfer serious negligence in the past and now occupies a global position as a source of food and industrial raw materials (NjokeJ.E., 2007). Nigerian is the abundance producer of sweet potato in Africa with annual output of 3.46 million metric tons and globally the second largest producer after china. However, this is the only crop among the root

and tuber crops that has a position per capital annual rate of increase in production in sub-Saharan Africa (Olagunju FL *et al.,* 20013).

Sweet potato (ipomoea balatas) is an herbaceous warm wetted creeping plant that belong to the family of convolulacease and genius of Ipomoeas (Mbansa E.O 2010). The family is mad of 45 genera and 1000 species. It grows best at temperature of between 24° to 28° with annual rainfall of 1000mm to 7000mmC.

In Nigeria, more 85% of the sweet potato production is done by farmers who maintain small farms and carry out their operations manually with traditional farm tools such as hoe and machete (Okonkwo J.C *et al.,* 2009). According to (Ugonnaet *et al*., 2013), the main sweet potato growing areas in Nigeria is Jos plateau and this could be attributed to its attitudes which range which range from 1200m to 1400m and summer temperature that rarely exceed 35°c which makes the temperature climate sweet able for potato production. Sweet potato has been identified to be the fourth most important root crop in Nigeria after cassava, yam, and cocoyam (Okonko J.C, 2009),

Postharvest loses are quite often the limiting factor of sufficient production of this particular crop. This may be due to several factors such as improper handling during and after harvest, deficiency in curing and storage infrastructure, lack of proper packing and grading, and also inadequate knowledge in global market requirements and opportunities (Siddique, 2005).

Sweet potato (*Ipomoea batatas L*) is an herbaceous warm watered creeping plant that belong to the family of convolulaceae and genus of Ipomoea (Mbansa, 2010). Sweet potato (*Ipomoea batatas(L*.) *Lam*.), is an important crop food security in many parts of the developing world. Sweet potato has a short growth cycle (four to five months); yields will in marginal area, and is drought tolerant. In addition to these agronomic advantages, sweet potato is good source of carbohydrate, fiber, vitamins and minerals (Woolfe, 1992). Sweet potatoes also contain phytochemicals which are good for human health. Despite all these nutritional and agronomic benefits, sweet potato is highly perishable after harvesting (Reese *et al*., 2003). The major causes of product losses are weight loss, sprouting and rotting (Ravi *et al.,* 1996). Control of sweet potato postharvest losses has generally been reliant on the manipulation of storage temperature and relative humidity, with the aim of achieving an ideal storage temperature of 15 degrees and a relative humidity of 80% to 95% (Picha, 1985a). In some cases, sprouting and rotting is controlled by use of hot water treatment. (Woolfe, 1992, Afek *et al*., 1998). However, these control methods are difficult to achieve for subsistence farmers whose villages are not network. The present study investigated the effectiveness of different hot water treatments in preserving the important qualities of sweet potato in order to reduce the usage of synthetic chemicals. The results could be a reference point for relevant parties to take necessary actions in providing a favorable treatment for potato tuber storage and providing an affordable control of diseases.

Material and Method

Sample Collection

One bag of Freshly harvested sweet potato tuber were purchased from Gamboru Market Maiduguri and transported to Ramat Polytechnic postharvest laboratory early in the morning and are allowed to cool for 1hr, clean and stored according to sizes and quality before subjecting

them to the experimental set up. About 128 were washed to removed dirt sorted and dust free sweet potato tubers

Preparation of Sweet Potato for Experiment

The treatment was laid in completely randomize design (CRD). There were four different treatment of hot water treatment that have been tested on sweet potato and each treatment was subject to 10 min, 15 min and 20 min immersion time, T2 (50^0C for 10 min), T3 (50^0C for 15 min), and T4 (50^0C for 20 min). Untreated (0 min control) sweet potato were immersed in sterile water at room temperature only (T1). All the treated sweet potatoes including 0min control were stored at normal room temperature (27^0C ± 2^0C) for 4 weeks. Three replicate had been set up for each treatment and each treatment has 2 number of sweet potato per replicate. The assessment of postharvest quality on treated sweet potato was conducted at every 1 week (7 days) interval for week.

Conduction of Experiment

32 tubers from each treatment were initially weighted and monitored at a 7 day (1 week) interval for 4 weeks. Weight loss percentage was calculated using this formula or equation

$$\text{Weight loss (\%)} \quad \frac{\text{Initially weight} - \text{final weight}}{\text{Initially weight}} \times 100$$

While the Appearance were evaluated using quality rating scale: visual quality rating:- 1 = excellent, fresh appearance; 2 = very good slightly defects; 3 = good limit of salability, defect; 5 = poor). (1 = no decay, 2 = 1-10% decay/slight; 3 = 11-25% decay/moderate; 4 = 26 – 50% decay/moderately 5 = more than 50% decay (Anna M et al., 2019).

RESULT AND DISCUSSION

Tuber Weight Loss

The result for hot water treatment at 4 weeks showed a significant difference among the treatments (Table 1). The control had 35% weight loss, which was significantly higher compared to other treatments. However, there was no significant difference between 20-minute 15-minute dipping time, which had 25% and 23% of weight loss respectively. Followed by 10-minute dipping time which had the lowest weight loss of 15%. The reduction of weight loss in the treatments compared to the control was attributed to the hot water treatment melting the wax and closing cracks while reducing weight loss, delaying ripening and slowing the degradation rate of peroxidase (Lurie et al., 1997).

Tuber Firmness

The observations (Table 1) on firmness display a significantly higher firmness on the fruits treated for 10-minute with a firmness value of 45.5 N, while the control had a significantly lower firmness value of 20.2 N. However, there was no significant firmness difference between the 15- and 20-minute treated fruits with the values of 30.3 N and 29.1 N, respectively. The results suggest that hot water treatment offers benefits in controlling fruit firmness, but prolonging the

period can cause adverse effects on fruit firmness. However, the results were much better than those in the control group were.

Rind thickness

Water loss from sweet potato tubers during storage results in shrinkage and fruit softening. The results (Table 1) for the rind thickness of sweet potato tuber showed a significantly lower rind size for the control compared to other treatments, with a size of 0.99 mm, but there was no significant difference at $P \leq 0.5$ between 15- and 20-min dipping times, with the rind thicknesses of 1.5 mm and 1,6 mm, respectively. Meanwhile, the 10-minute treatment had a highest rind size of 2.1.

Appearance

The observation on appearance of the fruit is presented in Table 1. Appearances showed significant differences at $P \leq 0.5$ between control and other treatment having 1.0 according to the scale of Anna et al., (2019). However, 0-min and 20-min dipping time had a significantly higher scale value of 4.0 respectively, followed by 15-min dipping time having a scale of 3.0. However, there was a significant difference between the 10-min and other treatments respectively.

Table 1. The main effect of hot water treatment on sweet potato tuber during storage.

Treatment	Weight loss (%)	Firmness (N)	Rind thickness (mm)	Appearance (1-5)
Control	35c	20.2c	0.99c	4c
10MIN	15a	45.5a	2.1a	2a
15MIN	23b	30.3b	1.5b	3b
20MIN	25b	29.1b	1.6b	4c

Means with the same alphabet are not significantly different at LSD ($P \leq 0.5$).
Note. Appearance scale of 1 = excellent, fresh appearance; 2 = very good slightly defects; 3 = good limit of salability, defect; 5 = poor). (1 = no decay, 2 = 1-10% decay/slight; 3 = 11-25% decay/moderate; 4 = 26 – 50% decay/moderately 5 = more than 50% decay

Conclusion

In the present study, sweet potato treated with (10 min) dipping time was able to maintain the weight loss firmness, rind thickness and appearance. It showed that hot water treatment of 10 min dipping time at temperature range of 50^0c has the potential in prolonging the shelf life of sweet potato by reducing decay and has the best ability to maintaining the quality of sweet potato tuber in comparison with the control and other treatments.

ACKNOWLEDGEMENT

Tertiary Education Trust Fund 2021TETF/DR&D/CE/POLY/MAIDUGURI/IBR/2021/VOL.I

Reference

Abong G.O, Ndanyi V. C.M., Kaaya A, Shibairos, Okoth M.W, Lamuka P.O, Odongo N.O, Wajekeche E, Mulindwa J, Sopade P. (2016). A review of production postharvest handling and marketing of sweet potato in Kenya and Uganda. Curr. Res. Nut. Food sci. 2016; 4 (3) doi:http/dx.doi.org/10.12944ICRNFSj.4.302.

Abu a OAC (2000) officer method of analysis 17th ed. ASSOC official Anal. Chem. Washington DC. 7181 – 91.

Adewola, M. A (2008). Potential of sweet potato leaf meal as dietary ingredient, Pakistan Journal of nutrition 7 (3): 444-449, 1680-5194

Ahn J.C 2020 postharvest temperature and flooding on sweet potato tubes in storage hot science 15: 251-259

Ahn, J.K., Collin, W.W., & Phar, D.M (1980). Influence of pre-harvest temperature and flooding on sweet potato roots in storage. Hort. science 15 (3) 261-263

Amral B. D. Y. K., Samuel & Mala B. (2011). Evaporate cooling system for storage of fruit and vegetable a review. Journal food science technology 50 (3): 429-442.

Angel, Frederic (1970). Exploitation of the chick cany on current Anthropology 55-58

Artchwager. E., &Starret, R.C. (1931). Suberization and would-periderm formation in sweet potato and gladious as affected by temperature and relative humidity. Journal of agricultural research, 34 (4) 353-364

Austin, Daniel F. (1988). The taxonomy, evolution and genetic diversity of sweet potatoes and related wild species exploration, maintenance and utilization of sweet potatoes planting conference, 1987. Lima, Peru: International potato, center 92-96

Baishya, R.S., Sarma G.C., &Baishya, D.N (1992). Studies on the change of rate of respiration during infection of sweet potato. Journal of exobiology 4 (1), 67-71

Bashasha., B., Mwanga, R.O.M., Ocitti P. Obwoya C.N., Ewell, P.T. (December 1995) Sweet potato in the farming and food systems of Uganda, A farm survey report (PDF) (report). Nairobi, Kenya. Kampla, Uganda International potato center.

Brash, D.W., Cheah L.H Hedderley D.I Oisson S., & Woolf, A.B. (2010). Hot water drenchers for control of sodt rots on washed kumara (sweet potato) Acta Horticulture, 880, 455 – 462.

Brash, D.W., Cheeh. L. H. Heddeley, D.I., Olsson S., & Woolf A.B (2010). Hot water drenches for control of soft rots on washed Kumara (sweet potato) ActaHorticulturae, 880, 455-462

Broadus E.W Collins W.W & phair D.M (1998) incidence and severity of hardcore in sweet potato as affected by genetis line curing and length of 1°c and 21°c storage scientia horticultural 13 (2) 105 – 113

Broadus, E.W., Collins, W.W., & Pharr, D.M. (1980). Incidence and severity of hardcore in sweet potato as affected by genetics line, curing and length of 1^0C and 21^0C storage. Scientia Horticultural 13 (2) 105-113

Cambell, G.M., Hernandez, T.P & miller J.C 1963. The effect of temperature photoperiod and other related treatments on following in Ipomea batetas proc. A.M SOC Hort Sci. 83, 618 – 622.

Cantwell, M., &Suslow T., (2013) sweet potato: recommendation for maintaining postharvest quality retrieve 5 December, 2014, from http://postharvest.ucdavis.edu/ptvegetables/sweetpotato

Centro international de la Pape (2009) sweet potato (retrieved 06.10.12 from http://ww.cipotato org. sweet potato).

Centwell, M.I Kang J., & Hong G. (2003) Heat treatment control sprouting and rooting of garlic clover postharvest Biology and technology, 30 ci, 57 – 67 doi,: http://dx.doi.org/10/ 1016/50 925 – 5714 (03) 00060-7

CIP ()citation international potato center) (1996) lima peru international 60 p la Mohna aprttado 1998, Lima 12 pero 511 – 34

CIP (International Potato Center) Lima, Peru, 2003. Sweet potato: treasure for the poor in sweet potato: treasure for the poor in sweet potato main page pp. 25

Clark CA, Moyer JW (1988) compendium of sweet potato disease (vol I, 1st Edn.), Aps press, saint Paul, 74 pp.

Clark, C.A. (2013). Compendium of sweet potato disease, pests and disorders. St. Paul, American Phytopathological society.

Colhins ww., 1984 progress in development sweet potato (ipomoea batatas (L) Lam) cultivate for fuel alcohol production in F.S shideler & H Rincon (eds). Proc. 6th symp. Int. Soc trop root crops cip, Ulm, Peru P 571 – 575.

Czhang, D. P, Ghislain, M, huaman Z, Cervantar J.C, carey EE (1999). AFLP assessment of sweet potato genetic diversity in four tropical American region International potato centara (CIP) program report 1997-1998 CIP

Dandago, M.A, Gunguls, D.T (February 2011) effective of various storage method on the quality and nutritional composition of sweet potato. In Yola Nigeria PDF international food research journal. University, Pura Malaysia 18 (1) 271-278 EISSN 2231 7546

Dasai & Wagh (2001). Quality and physiological change during different pre-

Devereau A.D 1994. Tropical sweet potato storage a literature review report. Natural resource institute chatham.

Devereau, A (20 May 1994). Tropical sweet potato storage: a literature review PDF. Report. Chather England. Oversea development administration. National Institute.

doi:http//dx.doi.org/10.1016/postharvest.2006.05.013

Endrias D., negussie R, Gullelat D. (2016) comparison of three sweet potato cipomea batatas (L) Lam) varieties on nutrition al and anti – nutritional factors global journal of science frontier research: D agriculture and veterinary, 16 (4), 1920 – 11 10 10161, trstmh. 2006 . 05.010

Ewell, P. (1993) Sweet potato Africa research priorities to stimulate increased marketing international workshop on method for agricultural marketing research. 16-20 march 1993. IARI campus, New Delhi India.

extension, the university of Georgia college of agriculture, pp. 2-10).

F.A.O (Food and Agricultural Organization of the United Nations) (2013). The state of food security in the world 2013. The multiple dimension of food security. Rome, Italy. FAO.

Fallik, E., (2004). Prestorage hot water treatment (immersion rising and brushing) postharvest biology and technology 32 (2) 125-134.

FAO (2005) general procedure for fruits and vegetable preservation agricultural service Bulletin, 119 , 37 – 116 food and agricultural organization (2005) FAO Rone, Italy

FAO (food and Agriculture organization of the United Nations) (2003) the state of food insecurity in the world 2013 the multiple dimension of food security Rome, Italy FAO 115, 39 -136

Faostat (2006) Agricultural production available online: http://faostat.fao.org/site 1567 /default.

Fawole, G.P. (2007). Constraint to production, processing and marketing of sweet potato in selected communities in Offa local Government area Kwara state.

Folquer, F., 1974 varietal efficiency in the spring production of sweet potato seeds (Ipomea Batates (L) Lam) field crop Abstract 29,881.

Food and agriculture organization of the united national FAOSTAT – [Citodo em 07 de Marco de 2020] Disponivel em: http://www.fao.org/faostatlen/#data/QC

HAHN, S.K &hozyo, Y., 1984 sweet potato in the physiology of tropical field crops eds. Goldsworthy P.R & N.M fisher, pp 551 – 558 John Wiley Chichester

Hand young V.C., 1961 sweet potato for till a lands of Tripura ind. Farming 29,27

Hu, W., & Tanakas S.T (2007) effects of heart potato journal of the science of food and agriculture 87(2), 313 – 319

Ismail, M.A. & Wilhitte, d.l. 1999. Keeping quality of Florida citrus in the home environment. Proceeding in the Florida state and horticulture society. 104: 77-80.

Jillian Kubala, M.S, R. 2019. Sweet potatoes are staple food in many part of the world written by mega were RDN LD

juice and food. Science and nutrition 50: 369-389.

K'osambo L.M., Carey, E.E., Misra, A.K, Willets J and Hagemimana, V. (1998). Influence of age, farming site and boiling on pro-vitamin A content inn sweet potato (Ipomoebatatas L.) storage roots. Journal of food composition analysis 11 (4) 305-321

Karauri, Edward gicholi, Ojijo, N.K.O (1 july 1994) storage studies on sweet potato.

Kintinojo, L. (1987). Effect of low concentration of ethylene on sweet potato during curing and storage. Acta Horticultural 201, 37-42

Laurie S.M van jaarsveld P.J, faber M. Philpot MF labus changue M.T (2012) trnas-b-carotene, selected mineral content and potential nutritional contribution of 12 sweet potato varieties J. Food compost Anal. 27:151 – 159

Lieberman, M., Crft, C.C., & Wilcox, M.S. (1959). Effect of chilling on the chlorogenicacide and ascorbic acid content of Porto Rico sweet potatoes. Journal of American society Horticultural science 74, 642-648.

Liu, S.C., Lin, J.T., & Yang, D.J. (2009). Determination of Cis and trans a- and b- carotenoids in Taiwanese sweet potatoes (Ipomoebatatas (L.) at various times. Food chemistry: 116 (3), 605-610

Low J., Lynam, J, Lemaga B, Crissman C, Bakr I, thiele G. (2009). Sweet potato in sub-saharan Africa, in the sweet potato springer Netherlands pp. 359-390.

Lurie, S. (1998). Postharvest heat treatment postharvest biology and technology 14 (3), 257-269

Mbansa E.O adoption and disadoption of sweet potatoes production and processing technology by farmers in south-eastern Nigeria. Ph.D thesis, department of agricultural extension University of Nigeria, Nsukka. Pp 1-104

Moreles Rodrigues Alfredo: Alfredo MorelesTejon, DawRodriguesz del Sol; Ivan Pasture Yclaudia A (mendez (2017). Origen Batatas (1) Lam). Una revision "Agricultural tropical: 1-13

Negeve J.M., Hahn, S.K & Bouwkamp JC 1992 effect of altitude and environment on sweet potato yield in Cameroon. Trop. Agr trindad 69, 43 – 48.

Njoku J.E (2007) effect of cultiva and time of harvest on yield and total carotenoid content of carotene-based sweet potato cultivas NRCRI. Annual report pp 45-53

Numes, m.c.n Delgado, a. & emond j.p. (2007), relationship between weight loss and visual quality of fruits and vegetable, proceedings of the florida state horticulture society 120, 235-245,

Odebode, S.O; Egeonu N. and Akonroda M.O (2008) promotion of sweet potato for the food industry in Nigeria Bulgaria journal agricultural science 14: 300 – 308.

Okonkwo J.C Amadi CO Nwosu KI (2009) Potato production, storage, processing and utilization in Nigeria. Intemal root crops Research institute, Umudike, Nigeria pp 67-69

Olagunju F.L, Fakayode S.B Babatunde R.O Ogunwole Olapade F. (2013) gender analysis of sweet potato production in Osun State Nigerian AJAEES 2 (i): 1 – 13

Olugungu F.L, Fakayode S.B, Babatunde R.O, Ogunwole-olapade F, (2013) Gender analysis AJAEES 2 (1): 1-13

Onwuence, I.C (1982) the tropical tuber crop, yams, cassava, sweet potato and cocoyams, Britain, English language book society/John willey and sons

Paul, R.E., & Chen. N.J (1999). Heat treatment prevent postharvest geotropics cultures of asparagus spear (Asparagus officinalis L.) postharvest biology and technology 16 (1) 37-41

Perry, L (2002). Starch granule size and the domestication of marioc (manihotesculanta) and sweet potato (Ipomeabatatas). Economic Botany 345-349

Picha (1986) Influence of storage duration and temprerature on sweet potato sugar content and chip color. Journal of food science, 51 (1), 239-240. Doi10.1111/j.1365-2621.1986.tb10883.x

Picha, D.H (1987). Chilling injury, respiration and sugar change in sweet potatoes stored at low temperature. Journal of American society of horticulture science 112 (3). 497-504

Posas, O.B, 1989 sweet potato as Animal feed Radix 11, 1 – 8.

Pursed Glove, John williams (1986). Tropical crops: D. Longman scientific and Technical. New York: Johnnwiley and Sons ISBN 978-0-582-466-66-1

Purselglove, John Williams (1968). Tropical crops long man scientific and technical New York; john willey and sons ISBN197-978-585-1

Ravi, V. (1994). Respiration of intact and damage sweet potatoes at different temperature and relative humidities: journal of root crops 20(2) 89-95.

Ravi, V., Aked, J., &Balagopalan, C. (1996). Review on tropical root and tubes crops storage methods and quality changes. Critical reviews in food science and nutrition, 36 (7) 661-709.

Ray and Ravi R.C., & Ravi, V. (2005). Postharvest spoilage of sweet potato in tropics and control measures. Critical reviews in food science and nutrition 45 (7-8), 623-644. Doi:10.1080/1040839050500455516

Rees, D., Kapinga, R., Mtunda. K., Chilosa, D. Rwiza, E., Kilima, M., Kiozya, H., &Munisi, R. (2001). Effect of damage on market value and shelf life of sweet potato in urban markets of Tanzania, tropical Science, 41-1-9.

Rees, D., Van Otrshort Q.E Ambolinyi L.B Mohanna, M. and tonlins, F.I, 2003b improving long term storage under tropical condition role of cultivar selected in D; rees van oirsrchat and R. kaping (Eds).

Rico, D., Martin-Diana, A.B., Barat, J. M., & Barry-Ryan, C. (2007). Extending and measuring the quality of fresh-cut fruit and vegetable: a review. Trends in food science and technology, 18 (7), 373-386.

Saini, M. (2010). Chemical composition and sensory analysis of fresh pineapple

Saleh, N., Jayasinghe, U., &Rahayuningsih, S.A. (2003). Present status and future research in sweet potato in Indonesia. Paper present the progress in potato and sweet potato research in Indonesia.

Sandifolo, V.S., Moyo., C.C., & Benes., I.R.M. (1998). Evaluation of the efficetiveness of storage methods for roots of improved sweet potato varieties. In M.O Akoroda& J. M. Tem (Eds), food security and crops diversification in SADC countries: the role of cassava and sweet potato to (pp. 460-464). Lusaka

Scriven F.M ngunguru G.T., & wills R.B.H (1988) hot water dips for the control of pathological decay in sweet potatoes scientia Horticulture, 35 (1), 1 -5

Sekioka, H., 1964 the effect of come environmental factors on the translocation and storage of carbohydrate in the sweet potato, potato and super beet: III bulletin of the faculty of agriculture Kyushu University 21, 131 – 148 (cited by Rev V & Indira, P) in: horticultural review 23, 277 – 316.

Sekioka, H., 1964 the effect of some environmental factors on the translocation and storage of carbohydrate in the sweet potato, potato and super beet iii bulletin of the faculty of agriculture Kyushu university 21, 131 – 148 (cited by Ravi, V & Indira. P) in horticultural reviews 23, 277 – 316

Siddique (2005). Studies on morphology growth and yield of some sweet potato genotype. M.Sc agricultural thesis department of horticulture Bangladash University, 7-14

storage of sweet potato. Lebensmitted weiss and technologies, 34. 206-214

Suda, I Oki T., Masuda M., Kobayashi M., Nishiba y., & fukuta, S. (2003) physiological functionality of sweet potato containing anthocyanin and their utilization in food Japanese Agricultural research quarterly, 37 (3), 167 – 173.

Summer P.E. (1984) harvesting, storage and curing of sweet potato cooperative of

Thompson, J.F. &Scheverman, R.W (1993). Cuining and storing California sweet potato retrieved 10 October, 2012 from http://ucanr-edu/data store files/234-1080.pdf.

Tomlin, K.I., Ndunguru, G.T., Rwiza, E., & Westby, A. (2002). Influence of preharvestcuning and mechanical injury on the quality and shelf life of sweet potato (ipomoebatatas L.) in East Africa. Journal of Horticultual science & biotechnology. 77 (4), 399-403.

Tomlins, K. Ree, D, Coote, C; bechoff, A.J OkwadiMassingue J.J Ray, R.J westby, A. sweet potato utilization, storage, small-scale processing and Marketing in Africa; in sweet potato: post harvest aspect in food, and industry; Ray, R.C, Tomlins, K.L Eds Nova science publishers, inc. new York, NY, USA in 2010; pp 271-293

Ton, C.S & hernnadez, T.P 1978 wet soil stress effect on sewwet potato J. A.M SOC. Hort Sci. 103. 600 – 603

Tripathi. P and Dubey . N.K (2004). Exploitation of natural products as an alternative strategy to control postharvest fungal rotting of fruit and vegetable. Postharvest fungal biology and technology 32 (3): 235-245

Udemezue, J.C., (2019). Profitablities and constraints to sweet potato production in Nigeria cur trends Biomedical Engineering and Bioscience. 002 2019. 19 (2): 556007.Doi:10.19080/CTBEB.2019.19.556007.

Ugonna C.U, Jolaoso Mo, Onwualu AP (2013) A Technological appraisal of potato value chain in Nigeria international Research Journal of Agriculture, science and soil science 3 (8) 767-769

USDA (US department of agriculture), agricultural research service (2009) USDA national nutrient data base for standard reference release 22. Nutrient data laboratory home page http://www. ars. Usda.govt ba/bhnrc/ndl, accessed 14 September 2012.

Van Oirshot. Q.E.A. Rees. D., Aked J., &Kihurain A (2006) sweet potatocultivas differ in efficiency of wound healing.postharvest biology and technology. 42 (1), 65-74

Wang, Y., harvest, R.J., white, R.A., & Kays. S.Y.C (1998). Influence of postharvest curing treatment on the synthesis of the volatile flavor components in sweet potato. Acta Horticultural 464, 207-212

Watanabe K. Ozaki K. & Yashiki T., 1968 studies on the effect of soil physical condition on the growth and yield of crop plants 7 effect of soil air composition and soil bulk density on the growth of sweet potato, Proc. Crop sci soc Japan 37. 65 – 69 (cited by V. Ravi & Indica P.): in horticultural review 32, 277 – 316

Watter, W.M. (1987). Effect of curing on sensory properties and carbohydrate composition of baked sweet potatoes. Journal of food science. 52 (4), 1026-1029. Doi:10.111/j.1365-2621-1987.tb14267x

Will, R.B.H., McGlassson, B., Graham D., & Joyce, D. (2007) postharvest: an introduction to the physiology and handling of fruit, vegetables and ornamental (5th Edition): Sydney, university of New south Wales Press.

Wills, R.B. H., Mc Glasson, B., Grahams D., & Joyce, D. (2007). Postharvest: an introduction to the physiology and handling of fruits, vegetables and ornamentals (5th ed.) Sydney: university of New South Wales press

Wilson, L.A 1982 tubenzation in sweet potato (Ipomea batatas (L) Lam). In proceeding of the first international sweet potato symposium Tainana, Taiwan AVRDC, P. 79 – 94.

Wool fe A Jennifer (1992) sweet potato; An untopped food resources, Cambridge University press UK; 32(1): 12 – 13.

Woolfe, J.A (1992). Sweet potato. An untapped food resource. Cambridge New York: Cambridge University.

Woolfe, Jennifer A (5 march 1992) sweet potato: an untapped food resource Cambridge UK Cambridge University press and the international potato center (CIP)

Yoshinaga, M., Tanako, M., &Nakatain, M. (2000). Change in anthocyanin content and composition of developing storage root of purple-fleshed sweet potato (Ipomoebatatas L.). breeding science, 50 (1), 59-64.