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ASSESSMENT OF TOTAL LIPIDS, POLYPHENOL LEVELS, AND POSSIBLE EFFECT ON STORABILITY OF TWO CULTIVARS OF YAM (*D. ROTUNDATA SPP.*)

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ABSTRACT
Yam (*D. rotundata spp*) cultivars; *elemsu (**cvi**)* and *ekunmo (**cvii**)* stored over a period of 16 weeks in modified yam barn were selected (at two weeks intervals) for analysis for total lipid as well as total polyphenol levels. The results obtained from the study showed significant (P<0.05) increase in total lipid levels between 8th – 10th storage weeks in ***cvi***, while ***cvii*** showed no significant (P>0.05) increase in lipid levels throughout the storage period. Between 10th – 12th week of storage however, ***cvi*** showed significantly (P<0.05) higher lipid levels compared to ***cvii***. The total polyphenol levels in the cultivars showed no significant (P>0.05) increase until between the 6th and 8th storage week but significantly (P<0.05) decreased between 12th and 14th week in ***cvi***. The significant (P<0.05) increase in total polyphenol levels in ***cvii*** between 4th and 12th storage week culminated in significant (P<0.05) decrease in both cultivars till the end of 16 storage weeks. Generally, ***cvi*** exhibited significantly (P<0.05) lower levels of total polyphenols compared to ***cvii*** throughout the storage period. In the stored yam tubers, the lipids generated mostly from acetate units resulting from sprout-assisted sugar metabolism showed enhanced levels in ***cvi*** than ***cvii.*** The likely auto-oxidation of enhanced lipid levels in stored tubers may stimulate lipid hydroperoxide and free radical generation in the cultivar. The reactive nature of these metabolites may also affect bio-molecules like carbohydrates and proteins levels in the tuber, or possibly affect membrane permeability which may adversely influence storability in the cultivar. Similarly, enhanced lipid hydroperoxide levels in stored tuber may also influence higher lipoxygenase activity in the cultivar and invariably procure increased vulnerability to biodeteriorative changes that may lead to shorter storage life in ***cvi***. Enhanced polyphenol levels in ***cvii*** may create additional biological advantage for increased resistance to microbial and fungi attacks; from the viewpoints of higher quinones and melanins levels. However, the increased astringency and susceptibility to browning which may result from enhanced quinone levels may affect the cultivars organoleptic properties and acceptance for culinary use.

KEYWORDS: Polyphenols, cultivars, *elemsu, ekunmo*, storability.

INTRODUCTION

Yam(*Dioscorea spp*), a basic carbohydrate staple in the tropics has great potentials not only as food and feeds for man and livestock but also for industrial applications in making adhesives, industrial starch for textile and drug excipients production Osagie(1998). Yam is high in carbohydrate content (20 – 31%), low in protein (1 – 4%) as well as lipid (1-1.5%). The low lipid content of yam on dry weight basis does not make significant impact in yam based diet *per see*, but enhances the taste and affect other physiological changes like tuber cellular integrity, resistance to wounding and bruising during transportation and harvesting among others. The high levels of unsaturated fatty acids in yam peel may explain its relative susceptibility to oxidative degeneration which constitutes the major cause of spoilage in stored yam Faboya(1981). Opute and Osagie (1978) demonstrated that linoleic and linolenic acids; the predominant fatty acids in yam constitute the substrate for lipoxygenases, and that the enzymes activity leads to accumulation of corresponding hydroperoxides and free radicals in tuber cells during storage. The resultant massive attacks of membranous structures by these reactive molecules may account for the characteristic disintegration associated with rotting of stored healthy yam tubers. Lipid hydroxylation constitutes a primary event during prolonged yam storage is the primary cause of decrease in lipid levels in stored yam. Faboya(1981). One of the adverse metabolic changes that predispose to tissue destruction and ageing in yam is the oxidative damage to its lipid Osagie(1992). The generated oxygen derived radicals from such process are capable of inducing unwanted tissue damages and destruction of the poly unsaturated fatty acids as well as vitamin A, among others Osagie and Kates(1986). Lipid peroxidation in yam also constitutes another important free radical mediated biological processes leading to decreased membrane fluidity, increased non specific membrane permeability, leaky membrane as well as inactivation of some membrane bound enzymes. These metabolic changes lead to biodeterioration and spoilage in stored tubers. It is important to pay attention to yam's membrane lipids when considering the factors that may allow for good post-harvest storage . Osagie and Opute (1981) examined the lipid contents of yam tuber during growth and maturation and found a large initial increase in total lipid content during growth, and a decrease towards maturity. This indicated a natural turn-over of membrane lipids with new biomolecules being synthesized and old biomolecules degraded during storage. An injury to tuber membrane lipid may reactivate metabolic reactions in tissues suddenly exposed to a richer medium in oxygen supplies than the tuber environment, and this may stimulate extensive enzymic degradations in the tuber. It has also been documented that yams stored at temperatures lower than 10-12^{0}C readily become vulnerable to chilling injury emanating from the possible changes in molecular ordering and fluidity of the membrane lipids in response to low temperature (Coursey,1968). Polyphenols constitute a structural class of natural, synthetic and semi-synthetic organic chemicals characterized by the presence of large multiples of phenol units. They are generally considered as antinutrients because they are capable of interfering with the absorption of nutrients as mechanism of plants defense against herbivore. Some polyphenols are traditionally used as dyes while others like tannins can be used as precursors in green chemistry to produce plastics or resins by polymerization with or without the use of formaldehydes or adhesives for particle board. They are also used for the production of cresolate to treat wood. Some polyphenols produced by plants in case of pathogens attacks are called phytoalexins. Animals produce salivary protein like IB5 as herbivores' adaptation to plants defence to counter the tannins astringent effects. High levels of polyphenols in some woods can explain their natural preservative ability against rot. Meanwhile, the high tannin content of yam tuber tend to reduce the value of yam as a suitable source of protein Osuji(1983). The vulnerability of these polyphenolic compounds in yam to oxidation in reactions modulated by polyphenoloxidase has important consequences for generation of metabolites that do act as chemical weapons of defense in growing as well as stored tubers. The generated polymerized products are implicated in off-flavour and astringency development in improperly stored yams. This astringency invokes a degree of bitterness in maturing as well as stored yams and found to be more marked in the upper (proximal) part of the tuber than the lower (distal) end and increases with storage Adamson and Abigor (1981). Most often, the bitterness encountered in maturing *D.rotundata* tuber at the extreme tail end may be sufficient enough to affect its culinary property as well as its acceptability. This bitterness decreases with maturation due to oxidative metabolism of the polyphenolic compounds, just as they are readily synthesized in stored tubers through the phenyl propanioc or shikimic acid pathway to serve as chemical weapon of defence against pathogens and predators in yam Goodwin and Mercer(1995).The present work is designed to study and compare levels and possible roles of these two metabolites in yam during storage with a view to assessing their likely effects on the storability of the selected cultivars, and how they influence the nutrient levels in yam. To achieve these objectives stored cultivars shall be withdrawn at two weeks intervals and the stated parameters investigated over the storage duration

MATERIALS AND METHODS

YAMS

Samples of wholesome Yam (*D. rotundata*) cultivars *elemsu (**cv I**)* and *ekunmo (**cv II**)* were harvested from farm location in Yagba West LGA, Kogi State, Nigeria, and stored in modified yam barn at the prevailing storage temperature (26±5^{o}C) and relative humidity (70 – 80%) during the 16 weeks storage period (Nov-Feb).

Chemicals

All chemicals used for the various experimental works were of analytical grade and were prepared according to the standard procedures as described in the various methods.

METHODS

Sampling

Two tubers each of *cultivar elemsu (**cv I**)* and *Cultivar ekunmo(**cv II**)* samples of similar weight (700 – 1000 g) and size were withdrawn from the modified Yam barn at two weeks intervals for stated treatments.

Assay for total polyphenol levels

This was carried out on the selected yam samples according to the procedure described by Osagie and Opoku (1984) based on complexing polyphenols with potassium hexacyanoferate III to generate a product capable of maximal absorption at 720 nm. Catechol was used as standard.

Total lipid determination

This was carried out on the selected yam samples according to the method described by Amarta (1992) based on the ability of Acidified Potassium Dichromate to readily oxidize lipid to lipid hydroperoxide; capable of absorbing maximally at 350 nm. Oleic acid was used as standard.

Statistical Analysis

The data obtained from the experimental works were analyzed using statistical package SAS/STAT version 8.1 (2000). Analysis of variance was done to determine significant effects among treatments at 5% level and mean separation was by Duncan Multiple Range test to establish statistical difference between the means.

RESULTS

The total lipid levels in CVI and CVII stored over a period of 16 weeks (Fig.1) showed significant ($p<0.05$) increase between the 6th and 8th week in CVI while CVII showed no significant ($p>0.05$) increase in levels throughout the storage duration. However, between the 10th-12th week of storage CVI exhibited significantly ($p<0.05$) higher levels of total lipid than CVII. This alludes to the fact that CVI showed generally higher levels of total lipid s during the 16 week storage duration.

The levels of total polyphenols in CVI and CVII undergoing storage (Fig. 2) showed no initial significant ($p>0.05$) increase except between the 6th -8th week in CVI from the onset of storage, though it significantly ($p<0.05$) decreased in levels between the 12th and 14th week. The significant ($p<0.05$) increase in total polyphenol levels in CVII between 4th and 12th week of storage culminated in significant ($p<0.05$) decrease in both cultivars till the end of storage. Overall, CVI generally exhibited significantly ($p<0.05$) lower levels of total polyphenols than CVII throughout the storage period.

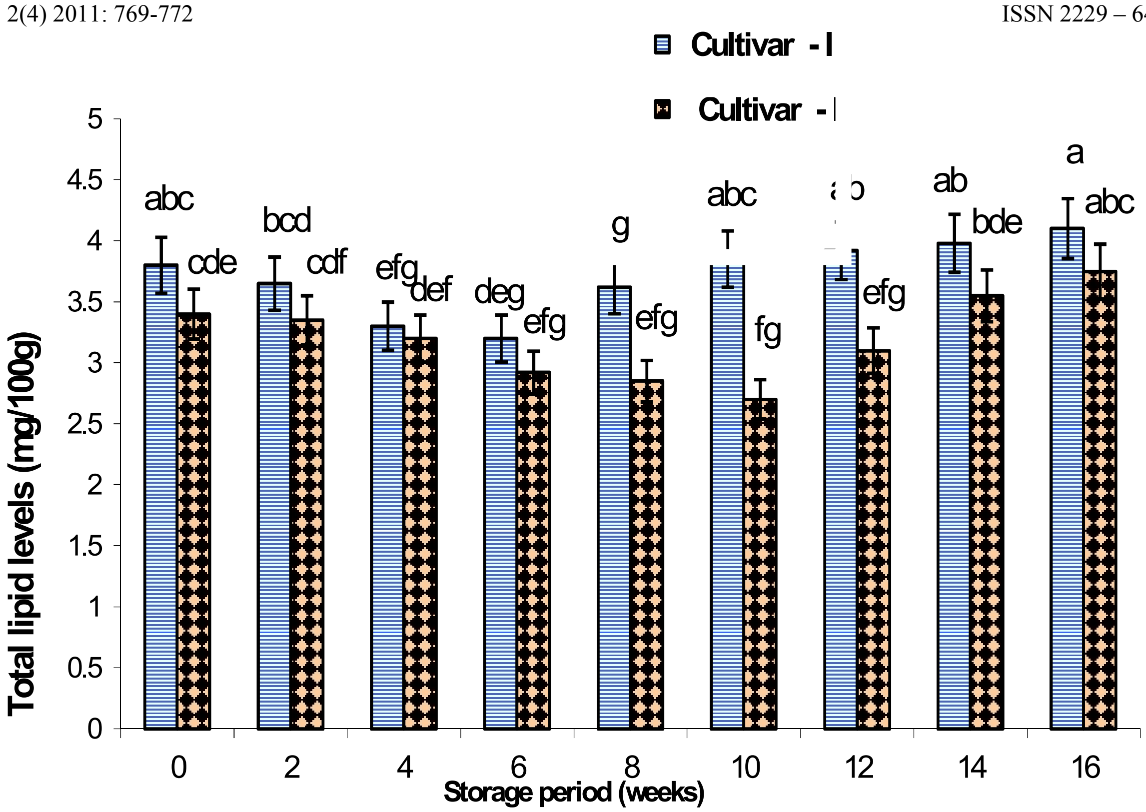

FIGURE 1. Total lipid levels in two cultivars of *D. rotundata spp*. stored over a period of 16-weeks. Each value represented means ± SEM of three determinations. Bars carrying different alphabets are significantly different (P < 0.05).

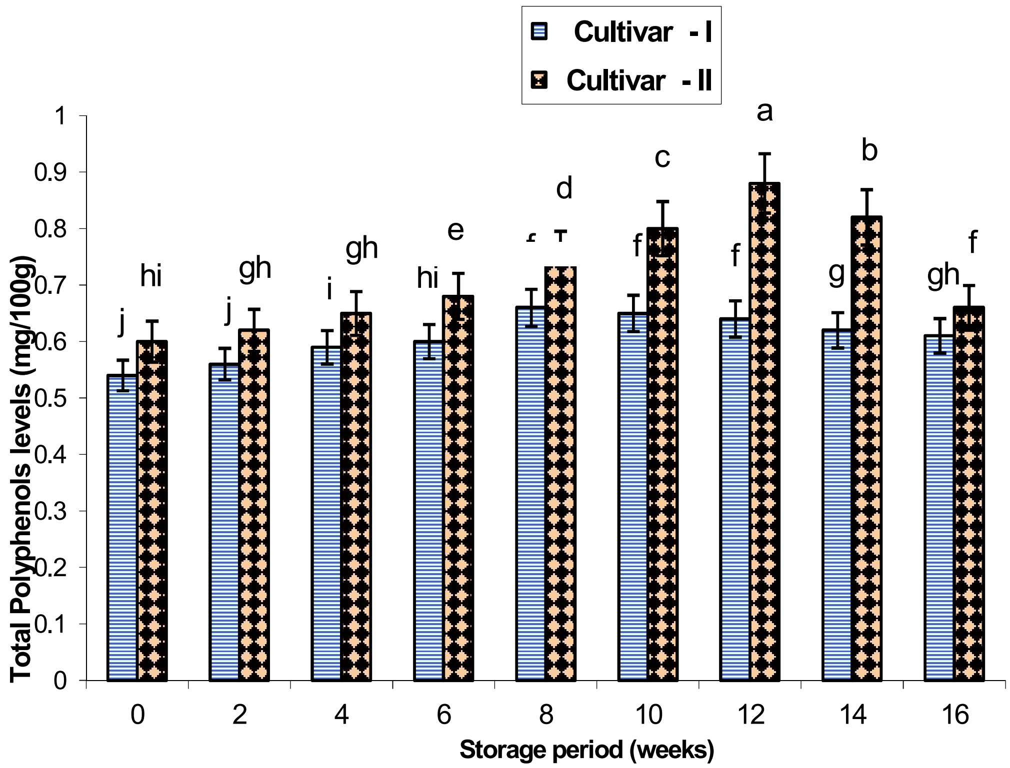

FIGURE 2. Total polyphenols levels in two cultivars of *D. rotundata spp*. stored over a period of 16-weeks. Each value represented means ± SEM of three determinations. Bars carrying different alphabets are significantly different (P < 0.05).

DISCUSSION

The biochemical changes associated with lipids and polyphenolic compounds in the cultivars during storage were employed to assess the cultivars relative storability as well as their nutrient composition. Lipids are synthesized from acetate units arising from sprouts assisted degradation of sugar in stored yam. The auto oxidation of such lipids to generate hydroperoxides and free radicals have important consequences on biological molecules in yam as well as and the tissue membrane. The enhanced lipid levels in ***cvI*** may induce increased biodeteriorative changes emanating from lipid oxidation process, generation of toxic hydroperoxides, as well as increased vulnerability to membrane damage in the cultivar Leshem *et al.,* (1986). Similarly, high lipid level may indirectly stimulate lipoxygenase activity which had been severally implicated in tissue destruction senescence and ageing in stored Yam Ikediobi and Oti (1986).

The enhanced level of polyphenol observed during sprouting underlines its importance to the process and this may procure biological advantage for increased resistance to microbial and fungal attacks during sprouting Kochbar (1986). Similarly oxidation of polyphenols generate quinones, melanins and other products which are capable of binding nutrients in yam, thereby reducing their bioavailability as well as exhibiting antimicrobial activity. The antimicrobial effects which were observed to be higher in ***cvII*** than ***cvI*** may suggest increased protection and higher resistance to microbial and fungal attacks in the former than the latter Adamson and Abigor (1980). However the effects of higher lipid hydroperoxide levels in ***cvI*** may predispose the cultivars to increased biodeteriorative changes resulting in short storability, while the protective and antibiotic effects of the products of polyphenol oxidation in ***cvII*** may among other factors underline the cultivars enhanced storability over ***cvI.***

CONCLUSION

The data obtained from this study lent credence to the comparative storability of ***cvI*** and ***cvII*** as portrayed by the biochemical indices employed. While the low storability of *cvI* may be associated with the enhanced total lipid as well as low polyphenol levels, the relatively higher storability of ***cvII*** may however, be associated with the higher polyphenolic compounds levels in the cultivar. Besides increased astringency in ***cvII,*** the enhanced levels of polyphenols may reduce nutrient bioavailability in the cultivar.

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