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# YIELDS COMPONENTS AND 48-H RUMEN DRY MATTER DEGRADATION OF THREE SWEET POTATO VARIETIES IN N'DAMA STEERS AS INFLUENCED BY DATE OF HARVESTING

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## ABSTRACT
*Two experiments were conducted to study the influence of harvesting date on three sweet potato varieties (TIS-87/0087, TIS-8164 and TIS-2532.OP.1.13). Fodder yields and leaf-to-stem ratio decreased ($P < 0.05$), while harvest index and 48-h rumen DM degradation increased with maturity from 12 to 20 weeks after planting (WAP). Mean root yields and leaf-to-stem ratio were higher ($P < 0.05$) in variety TIS-8164, while TIS-87/0087 recorded lower root yield and TIS-2532.OP.1.13 gave lower leaf-to-stem ratio.*

**Keywords:** Date of harvesting, fodder yields, root yields, Leaf-to-stem ratio

## INTRODUCTION
Sweet potato (*Ipomoea batatas* (L.) Lam.) adapts to a wide range of environmental and climatic conditions (Ezumah *et al*. 1987). Where smallholder farmers keep some livestock, forage yields and quality command additional importance (Orodho *et al*. 1996). The existence of differences in yields and components of yield among sweet potato varieties have been widely reported in the literature (Levett 1992; Nakatani 1993). Newly developed varieties with little information about their agronomic and nutritional characteristics calls for further studies (Larbi *et al*. 2007). The study aimed at identifying the most appropriate harvesting dates for three dual-purpose high to medium potentials sweet potato varieties for optimum yields under rain-fed agricultural farming systems in a subhumid zone of Nigeria and fodder quality using 48-h rumen degradation study in N'Dama steers.

## MATERIALS and METHODS
*Site and description of varieties*
Two experiments were conducted on the Research Farm of ILRI (International Livestock Research Institute), Ibadan (07º30′ N, 03º54′ E). Mean weather data were annual rainfall 1648 mm over 139 d, relative humidity 75% (56 to 95%), solar radiation 14.04 MJ/m$^2$.day and temperature 25.9ºC (21.7 to 30.2ºC). The experiments were sited on a 75 x 200 m plot with sandy-loam soil with crops established on ridges. About 7-d prior to plant establishment, plots were sprayed with Gramoxone® (broad spectrum post-emergence harbicides for grass and broad-leaf weeds) and Premextra® (broad-leaf specific pre-emergence herbicide). One medium yield variety (TIS-2532.OP.1.13) and two high yield varieties (TIS-87/0087 and TIS-8164) of sweet potato obtained from the National Root Crops Research Institute (NRCRI) in Nigeria were evaluated. The

varieties were selected based on results obtained from a previous study by Larbi *et al*. (2007).

*Experiment 1: effects of harvesting date on yields and yield components*

Experiment 1 was set up as split-plot design in June of each year to investigate the influence of harvesting date on yields and yield components of the three varieties. Main-plots were three varieties (TIS-87/0087, TIS-8164 and TIS-2532.OP.1.13) and sub-plots were three harvesting dates (12, 16 and 20 WAP). Disease and weevil-free fresh vine tips, measuring 0.20 to 0.25 m and carrying four to five nodes, were planted with two to three nodes underground at 45º to the ridge top in holes prepared by using sharp-pointed sticks of about 4 cm diameter. Planting space was 0.25 m intra-row and 1.00 m inter-row. Hand weeding was done at 14 days after planting (DAP) and thereafter as required when plots were weedy until there was complete ground cover by the plants. At six WAP, inorganic fertilizer (NPK 15:15:15) was applied as side dressing at the rate of 250 kg/ha.

Harvesting was at 12, 16 and 20 WAP by total handpicking of the roots after determining whole top yields above ground level. Sampling was done using six randomly placed 1 x 1 m sized quadrats, covering an average of three plants per quadrat for each harvesting date. Data collected at the time of harvesting included fodder yields, root yields, harvest index, and leaf-to-stem ratios. Foliage DM contents were determined at 60ºC for 72 h and root DM determined at 80ºC for 72 h in a Gallenkamp force-drought oven. Dried foliage samples were preserved for rumen DM degradation.

*Experiment 2: rumen DM degradation*

The dried foliage samples obtained from Experiments 1 were milled through a 2.5 mm screen using laboratory hammer mill and used for incubation in three rumen-fistulated N'Dama steers of average bodyweight 267 kg and about 42 months old. They were housed in individual pens measuring about 2.0 x 2.5 m with half-walls made of wood. Animals were offered maize stover *ad libitum* as basal diet supplemented with 1.5 kg wheat bran daily at 08:00 h, after discarding the leftovers of the previous day. The steers had free access to mineral licks and clean drinking water throughout. Incubation commenced after 10 d of maintaining animals on this feeding regimen. About 3 g of samples were incubated, in duplicates, in the rumen for 48-h with DM disappearance considered as 48-h rumen DM degradation (Ørskov and McDonald 1979).

*Statistical analyses*

Data from Experiments 1 were subjected to analysis of variance (ANOVA) procedures as split-plot using SAS (1989) software package. Sweet potato varieties were the three main-plots and harvesting dates were the sub-plots with six or four replicates (quadrats sampled), respectively. Variety x replicate interaction was used as error term to test for differences between varieties. Data from both years were bulked when the year effect was not significant. The 48-h rumen DM disappearance (dmd) data from Experiment 2 were analysed as 3 x 3 factorial arrangement in a split-plot design with main-plot factor as variety and sub-plot factor as harvesting date as described by Gomez and Gomez (1984). Variety x replicate interaction also served as error term for testing differences between varieties. And when *F*-tests showed significant differences, mean separation was carried out using least significant difference (LSD) option at 5% probability level.

## RESULTS

*Effects of harvesting date on yields and yield components*

The results for fodder yields (Table 1) indicated that there were no significant differences ($P > 0.05$) among the varieties at 12 and 16 weeks after planting (WAP) while at 20 WAP it ranged ($P < 0.05$) from 0.99 t/ha DM for TIS-87/0087 to 1.95 t/ha DM for TIS-2532.OP.1.13. The mean fodder yields showed that it ranged from 1.60 t/ha DM for TIS-87/0087 to 2.30 t/ha DM for TIS-2532.OP.1.13 while, across harvesting dates it varied from 1.45 t/ha DM at 20 WAP to 2.62 t/ha DM at 12 WAP suggesting that fodder yields decreased with maturity from 12 to 20 WAP.

**Table 1. Fodder yields of three sweet potato varieties harvested at 12, 16 and 20 weeks after planting (WAP) in 1999 and 2000**

| | Fodder yields (t/ha DM) | | | Mean | S.E.D. |
|---|---|---|---|---|---|
| Sweet potato variety | 12 WAP | 16 WAP | 20 WAP | | ($P = 0.05$) |
| TIS-87/0087 | 2.54 | 1.25 | 0.99 | 1.60 | 0.543 |
| TIS-8164 | 2.60 | 1.71 | 1.42 | 1.91 | 0.495 |
| TIS-2532.OP.1.13 | 2.72 | 2.24 | 1.95 | 2.30 | 0.480 |
| Mean | 2.62 | 1.73 | 1.45 | | |
| S.E.D. ($P = 0.05$) | 0.613 | 0.477 | 0.427 | | |

There was no significant ($P > 0.05$) variety by harvesting date interaction for root yields (Table 2). The overall results showed that root yields varied ($P < 0.05$) between 7.18 t/ha DM in TIS-87/0087 and 9.94 t/ha DM in TIS-8164 while, root yields increased from 7.76 t/ha DM at 12 WAP to 9.48 t/ha DM at 20 WAP.

**Table 2. Root yields of three sweet potato varieties harvested at 12, 16 and 20 weeks after planting (WAP) in 1999 and 2000**

| | Root yields (t/ha DM) | | | Mean | S.E.D. |
|---|---|---|---|---|---|
| Sweet potato variety | 12 WAP | 16 WAP | 20 WAP | | ($P = 0.05$) |
| TIS-87/0087 | 6.29 | 6.92 | 8.32 | 7.18 | 1.681 |
| TIS-8164 | 9.08 | 10.16 | 10.57 | 9.94 | 1.833 |
| TIS-2532.OP.1.13 | 7.90 | 8.64 | 9.55 | 8.70 | 2.263 |
| Mean | 7.76 | 8.57 | 9.48 | | |
| S.E.D. ($P = 0.05$) | 1.534 | 1.942 | 2.302 | | |

The results of leaf-to-stem ratio exhibited a significant variety by harvesting date interaction ($P < 0.05$), which ranged from 2.14 in TIS-8164 to 2.52 in TIS-87/0087 at

20 WAP while, it varied from 1.09 and 0.85 in TIS-2532.OP.1.13 to 1.83 and 0.91 in TIS-8164, respectively at 16 and 20 WAP (Table 3). These differences in leaf-to-stem ratios are expected to influence their forage/foliage quality. Generally, the leaf-to-stem ratios varied between 1.47 in TIS-2532.OP.1.13 and 1.63 in TIS-8164 but declined from 2.38 at 12 WAP to 0.87 at 20 WAP.1

**Table 3. Leaf-to-stem ratio of three sweet potato varieties harvested at 12, 16 and 20 weeks after planting (WAP) in 1999 and 2000**

| | Leaf-to-stem ratio | | | | |
|---|---|---|---|---|---|
| Sweet potato variety | 12 WAP | 16 WAP | 20 WAP | Mean | S.E.D. (*P* = 0.05) |
| TIS-87/0087 | 2.52 | 1.34 | 0.86 | 1.57 | 0.463 |
| TIS-8164 | 2.14 | 1.83 | 0.91 | 1.63 | 0.356 |
| TIS-2532.OP.1.13 | 2.49 | 1.09 | 0.85 | 1.47 | 0.402 |
| Mean | 2.38 | 1.42 | 0.87 | | |
| S.E.D. (*P* = 0.05) | 0.617 | 0.374 | 0.230 | | |

*Rumen DM degradation with varying harvesting dates*

The 48-h rumen DM degradation of sweet potato botanical fractions (whole top; leaf; stem) with varying harvesting dates (12; 16; 20 WAP) is presented in Figure 1. The figure indicates that whole top for TIS-87/0087 exhibited steady decline in degradation, TIS-2532.OP.1.13 showed steady increase with maturity from 12 to 20 WAP while, TIS-8164 recorded the highest degradation at 16 WAP. In the leaf, TIS-87/0087 did not show noticeable difference in degradation with maturity but both TIS-8164 and TIS-2532.OP.1.13 showed marked differences in degradation with the least recorded at 16 WAP. The degradation of the stem indicated that TIS-87/0087 and TIS-2532.OP.1.13 peaked at 16 WAP while, TIS-8164 increased in DM degradation with maturity although there was a higher increment from 12 and 16 WAP.

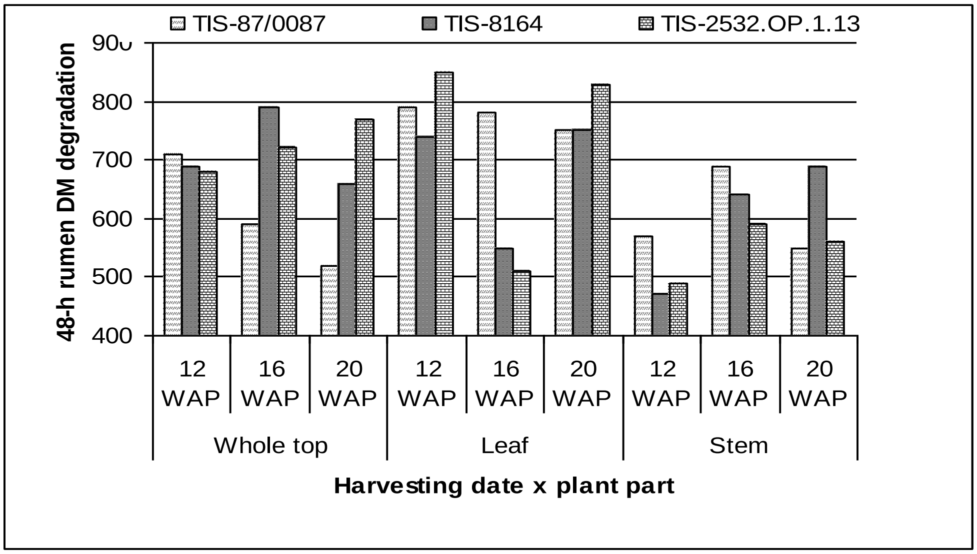


**Figure 1.** Variations in 48-h rumen DM degradation (g/kg DM) in the whole top, leaf and stem from three sweet potato varieties harvested at 12, 16 and 20 weeks after planting (WAP).

## DISCUSSION

*Effects of harvesting date on yields and yield components*

The effects of harvesting date of the three sweet potato varieties on yields and yield components (Table 1) indicated that fodder yields decreased with increasing harvesting date 12, 16 to 20 weeks after planting (WAP) while, fodder yields varied in the order TIS-2532.OP.1.13 > TIS-8164 > TIS-87/0087 across harvesting dates. The trend of fodder yield as recorded for the study was contrary to the results by Larbi *et al*. (2007) where variety TIS-2532.OP.1.13 gave lower fodder yield at the respective harvesting dates. The difference in trend is partly due to difference in location (Ibadan versus Umudike all in Nigeria).

Root yields were higher at 20 WAP for all three varieties and lower at 12 WAP (Table 2). Alcoy *et al*. (1993) made similar observations from their study that mean root yields in sweet potato increased as the time of harvest increased from 90, 105 to 120 days after planting (DAP) with the 105 DAP recording the optimum harvesting date. Across the three harvesting dates (12, 16 and 20 WAP), root yields were lower in TIS-87/0087. The findings from the study showed that the time of harvesting depends upon the variety of sweet potato in agreement with previous work (Ramirez 1992).

Leaf-to-stem ratio decreased in the three sweet potato varieties with increasing age at harvest (Table 3). Variety TIS-87/0087 showed greater defoliation, while TIS-8164 retained more leaves, proportionately, as the age at harvest increased from 12, 16 to 20 WAP. At 12 WAP, leaf-to-stem ratio was lower in variety TIS-8164 and higher in variety TIS-87/0087, at 16 and 20 WAP it was lower in variety TIS-2532.OP.1.13 and higher in variety TIS-8164. The ability of variety TIS-8164 to retain more leaves with maturity suggests that it could be used even during the drier periods of the year.

*Rumen DM degradation with varying harvesting dates*

The changes in 48-h rumen DM degradation with varying harvesting date for the whole top, leaf and stem among the three sweet potato varieties (Figure 1) showed marked differences among the botanical fractions and dates of harvesting. In the whole top, TIS-87/0087 exhibited steady decrease but TIS-2532.OP.1.13 showed steady increase with increasing maturity, while TIS-8164 recorded higher 48-h rumen DM degradation at 16 WAP. Yu et al. (2003) investigated the effects of variety and maturity stage of timothy (*Phleum pratense* L. cvs. Climax and Joliette) and alfalfa (*Medicago sativa* L. cvs. Pioneer and Beaver) and demonstrated that varieties had minimal effects on nutritive value, while stage of cutting had a large impact on rumen degradability in agreement with the findings from this study.

In the leaf, TIS-87/0087 did not show changes in 48-h rumen DM degradation with increasing maturity, while varieties TIS-8164 and TIS-2532.OP.1.13 were similar at 12 and 20 WAP, respectively but lower at 16 WAP in 48-h rumen DM degradation. The lower 48-h rumen DM degradation at 16 WAP in varieties TIS-8164 and TIS-2532.OP.1.13 may have resulted from increased sink action at the time although, the similarity in rumen degradation by variety TIS-87/0087 could not be explained.

In the stem, TIS-8164 increased in 48-h rumen DM degradation with increasing maturity, while it was higher at 16 WAP in varieties TIS-87/0087 and TIS-2532.OP.1.13. The higher 48-h rumen DM degradation in the stem fraction at 16 WAP could partly be explained by the fact that the stem is a known major sink channel in the sweet potato crop. Thus, the higher sugar deposits awaiting translocation to the relevant plant storage organ (which in this case is the root) prior to harvesting and processing for the study might have contributed to the trend.

## CONCLUSION

The studies have shown that yields and quality of sweet potato varieties differed with different harvesting dates within a given environment. Thus, farmers could embark on appropriate crop variety management practices to ensure optimum fodder and root yields/quality under smallholder crop-livestock production systems. Based on observed results from the study, this timing seems to be harvesting the crop at 16 weeks after planting (WAP). Such a planned cultivation process could guarantee sustainable yields and quality of root for human consumption all-year round while simultaneously producing good quality forage for utilization by livestock.

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