Storage of fresh sweetpotato roots to reduce puree supply chain risks

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Presented at the SPHI meeting – Dar es Salaam, Tanzania, 25-26 September 2017

Presentation outline

Objective

Background context

Approach

Findings

Discussion points

Objectives

- To maintain the quality of fresh sweetpotato roots for processing into puree during a four month storage period in a commercial-sized store in a tropical area of sub-Saharan Africa
- To determine if the quality of stored fresh sweetpotato roots is affected by:
  - washing of the roots prior to storage;
  - variety;
  - or solar as opposed to mains power supply of the store

Background context

- A large Kenyan supermarket chain is using orange-fleshed sweetpotato puree in its bakeries to produce a vitamin A rich bread which urban consumers enjoy
- **To maintain such market opportunities, the processors need to provide a year-round supply of high quality OFSP puree**
- To do this, they require fresh OFSP roots. However sweetpotato production is rain-fed, and there are gluts and shortages in the root supply during the year and associated price fluctuations
- Could storage of fresh roots help overcome this challenge?

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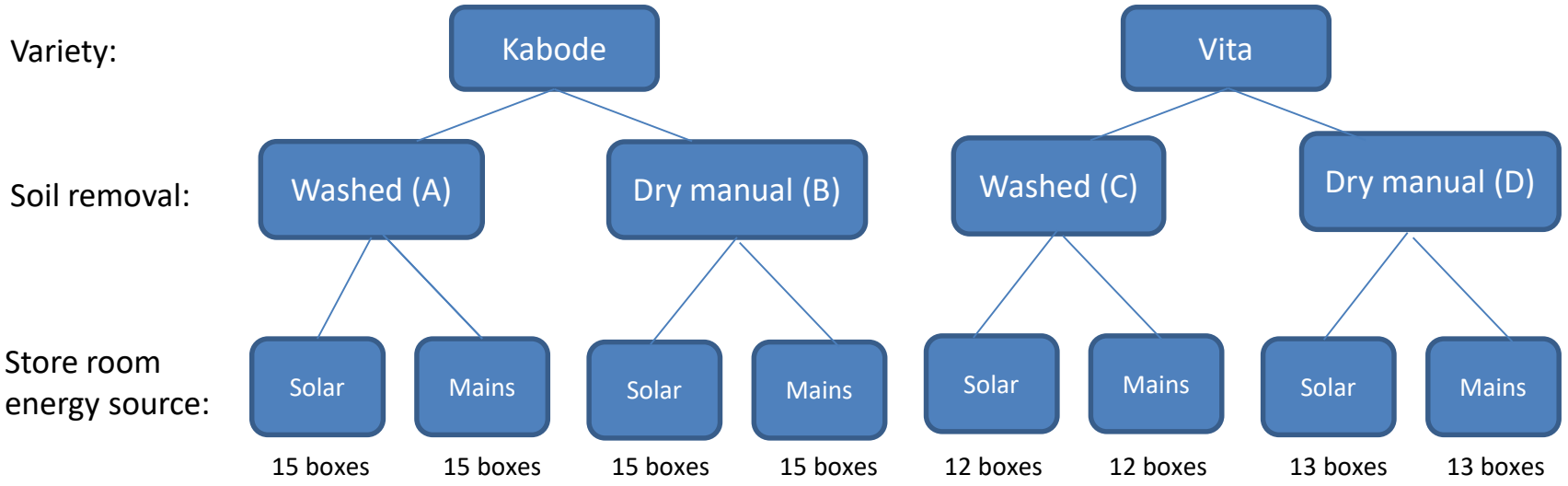
Approach – Treatments and set-up (1/4)

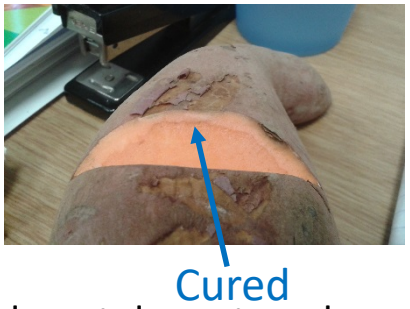


Storage duration: 0, 2, 4, 6, 8, 13, 16 weeks

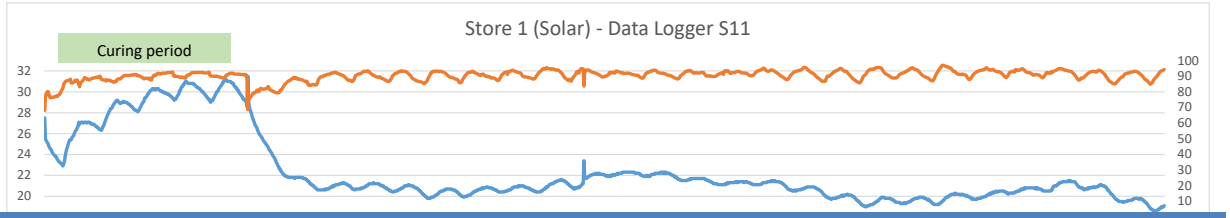
LTS4 trial set up on 13&14 Dec 2016; ~35-40 kgs roots per crate
NB: Limited Vita roots hence fewer crates


Rejected OFSP roots

Approach – Root curing (2/4)



- Sweetpotato roots retain the ability to heal wounds after harvest.
- To "cure" roots at start of storage are exposed to high humidity so that wounds do not dry out, and warm temperatures so that roots can actively metabolise.
- The wound-healing process involves the synthesis of a layer of lignin to provide a barrier to water loss and entry of rotting pathogens, followed by the synthesis of a new periderm (skin) underneath this.



1. Uncertainty over curing period required
2. Wanted to compare external and internal signs
3. ~12 roots per trt had small areas of peel removed and were placed in stores
4. Each day we cut into the roots to see if the periderm had thickened or not
5. It took 5 days of curing at 30C & 95% rh for this to happen, although externally roots appeared to cure within 1-2 days.
6. Curing conditions were kept on for 5 days in stores and then active cooling started on 6th day (8am on 19/12/2016)

Approach – Experimental design (3/4)

Sampling plan and calendar - LTS 4 (Dec 2016)

Sampling:	Month 1	Month 2	Month 3 & Week 2	Month 4 & Week 6

Store 1 - Solar powered

Back wall

B2	B22	A14	A3	A7	top
D21	A32	A9	A21	B17	middle
C21	B8	A6	D9	B32	bottom

D27	C8	C1	C2		top
B9	D7	A29	D3		middle
B31	A26	D13	C23	B15	bottom

D26	D2	A30	D25	B24	top
C17	B25	A16	A17	D5	middle
D6	B12	D28	D11	A19	bottom

B11	B7	C9	A13	top
B23	C4	C12	C7	middle
B14	C19	C11	A23	bottom

Door

Store 2 - Mains powered

Back wall

A15	D15	B19	B1	D4	top
D12	A18	B6	A10	A24	middle
D22	C18	A12	A25	C16	bottom

B13	D19	C10	A8	A27	top
A2	A33	D1	B3	C20	middle
D14	A20	B16	D17	B18	bottom

B26	A1	C6	C24	A28	top
D8	A5	C3	C15	C14	middle
A22	B29	A11	C13	D10	bottom

B28					
A4	B33	C5	D18	B4	top
B27	B21	B5	B30	D16	middle
A31	B20	D20	C22	B10	bottom

Door

Approach – Sampling (4/4)

Raw root quality analysis




Each box weighed: roots counted, scored for general appearance, sponginess, shrivelling

Roots sorted, count and weigh of good quality and defective. The defective then counted and weighed 1st by surface damage, then by sprouted, then by weevil damaged, then by rotten. Portion of rotten and weevil roots needing discarding then cut out and weighed.

3 randomly selected roots of each treatment then vacuum packed and sent to FANEL for lab analysis (mc, Beta-carotene)

Simple quality analysis of puree





25 kgs roots/ treatment, washed, steamed, cooled, cut, pureed.

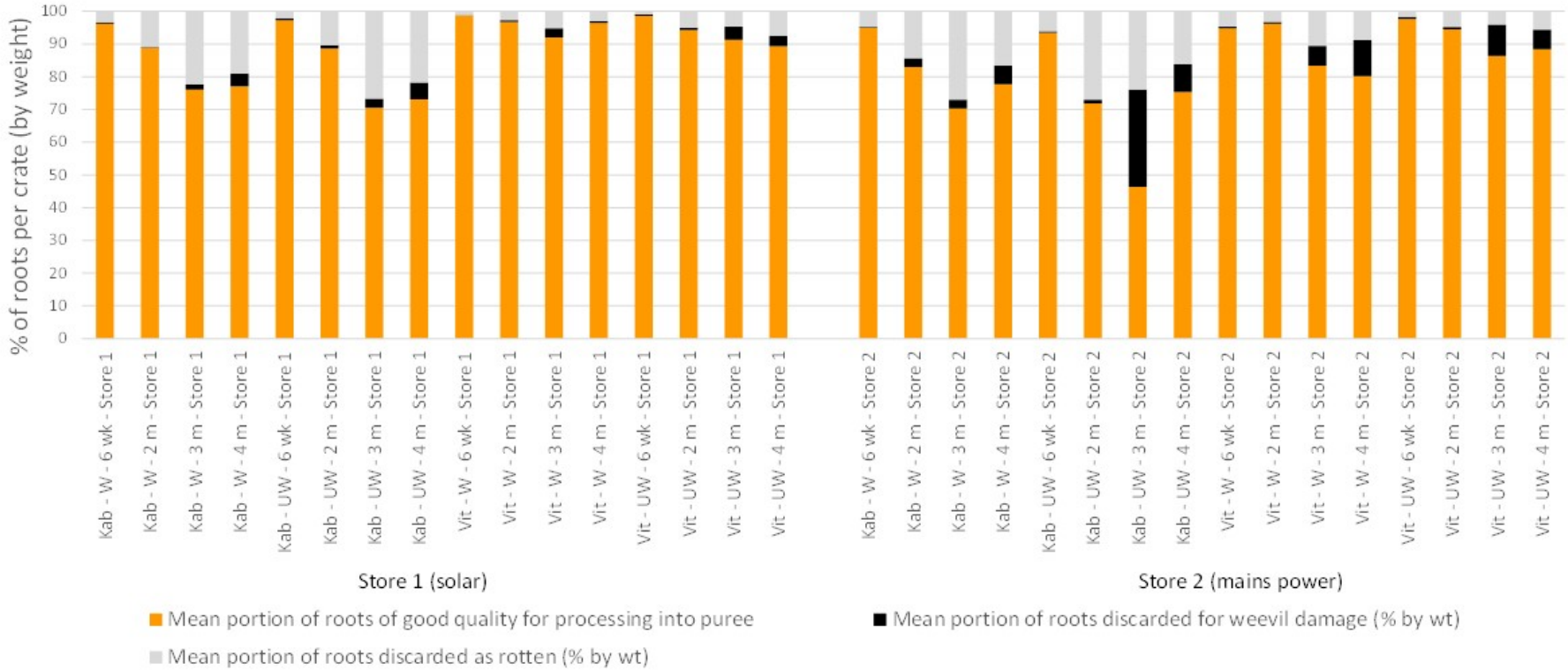
Sugar content (brix refractometer), puree stickiness, thickness, colour recorded. Puree sample sent to FANEL for betacarotene and bread making quality analysis

Findings (1/5)

Portion of roots needing discarding from puree chain after 4 months storage for this crate of Kabode (washed) roots

Findings (2/5)

Figure 1. USABLE and UNUSABLE PORTION of stored roots by storage duration, variety, soil removal treatment and store power sources at Organi Ltd., Dec 2016 to April 2017 (n=3)

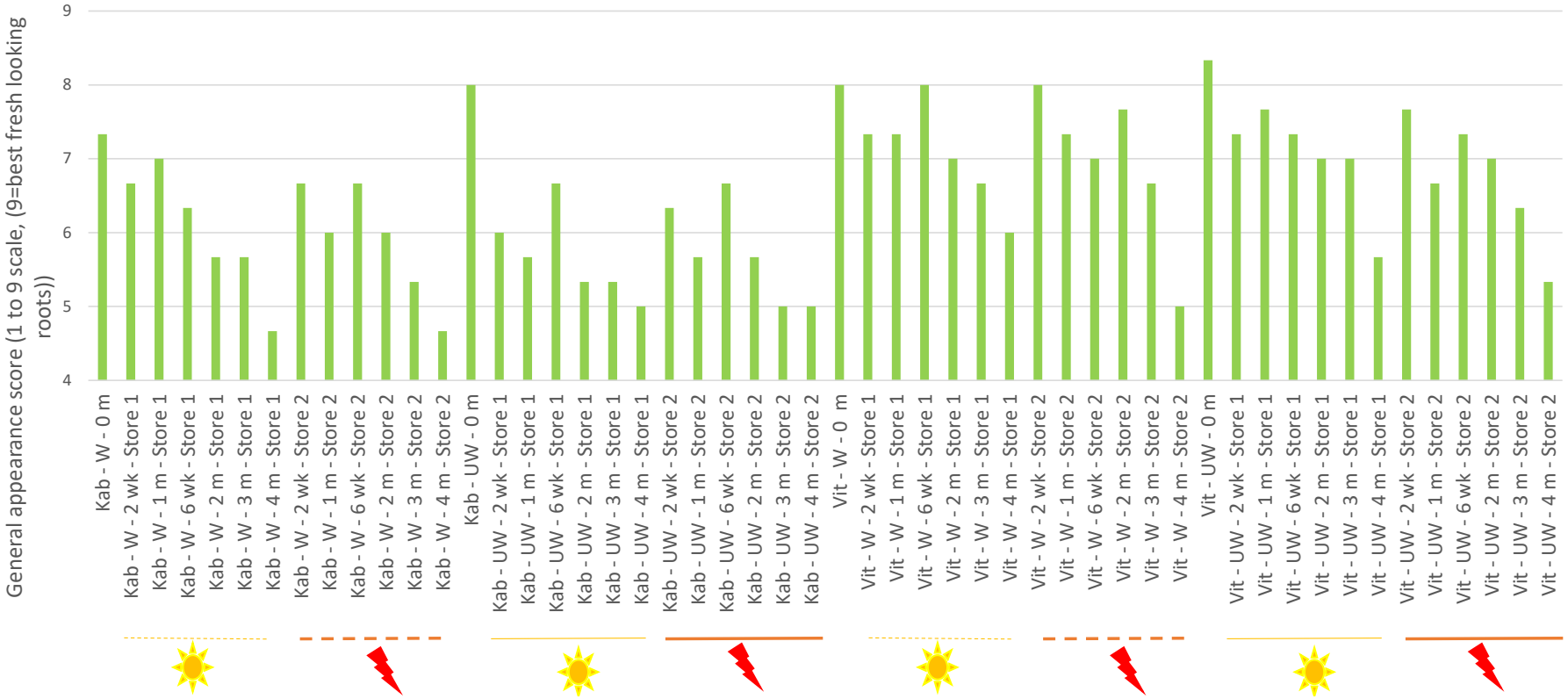


Treatment codes: Kab = Kabode; Vit = Vita; W = washed; UW = unwashed; 6 wk = 6 weeks storage; 2 m = 2 months storage; Store 1 = solar; Store 2 =mains. Kab-UW-4m-Store 1 = Unwashed Kabode roots stored for 4 months in solar powered store

- Fresh root storage can extend the time period for processing the roots into puree
- >70% of root weight could be processed into puree after 4 months storage in the solar powered store
- Larger portion of Kabode roots were discarded than Vita
- Root washing and store room power source did not greatly affect portion of roots requiring discarding

Findings (3/5)

Figure 2. Comparison of mean root GENERAL APPEARANCE SCORE per crate of sweetpotato roots stored for different durations using different treatments at Organi Ltd., Kenya (n=3).



- General appearance of Kabode dropped faster than that of Vita whether Washed or Unwashed
- By 4 months all general appearance scores had dropped to 4.5 -5.5 as they no longer looked fresh, as some roots exhibited rots, weevil damage and sprouts

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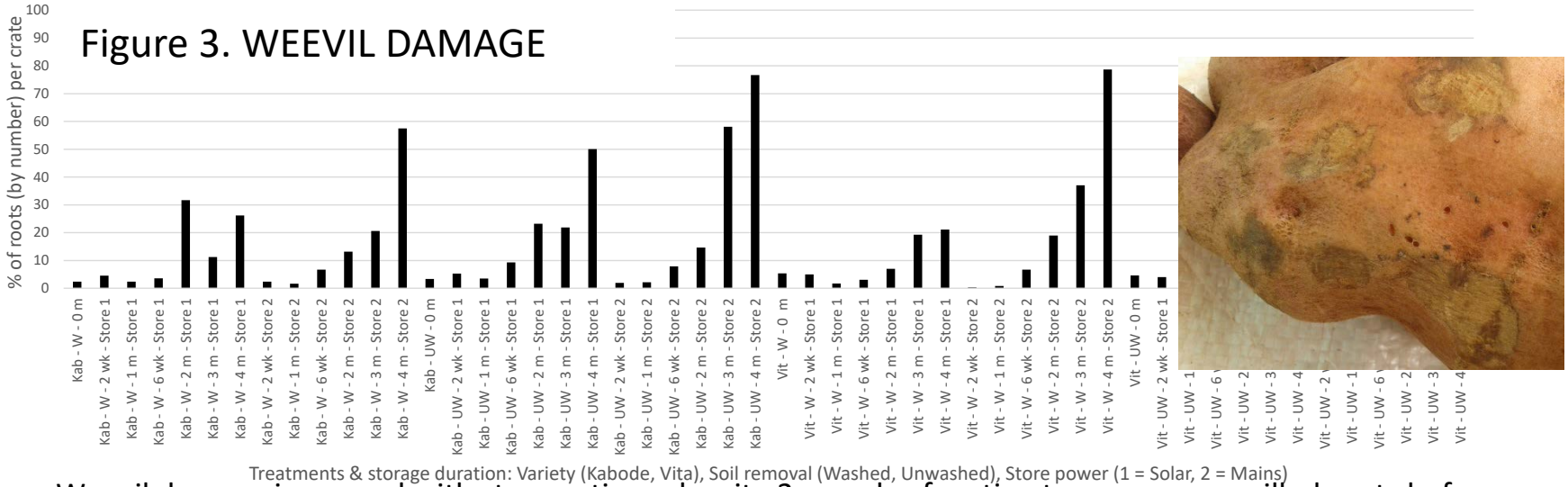
Findings (4/5)

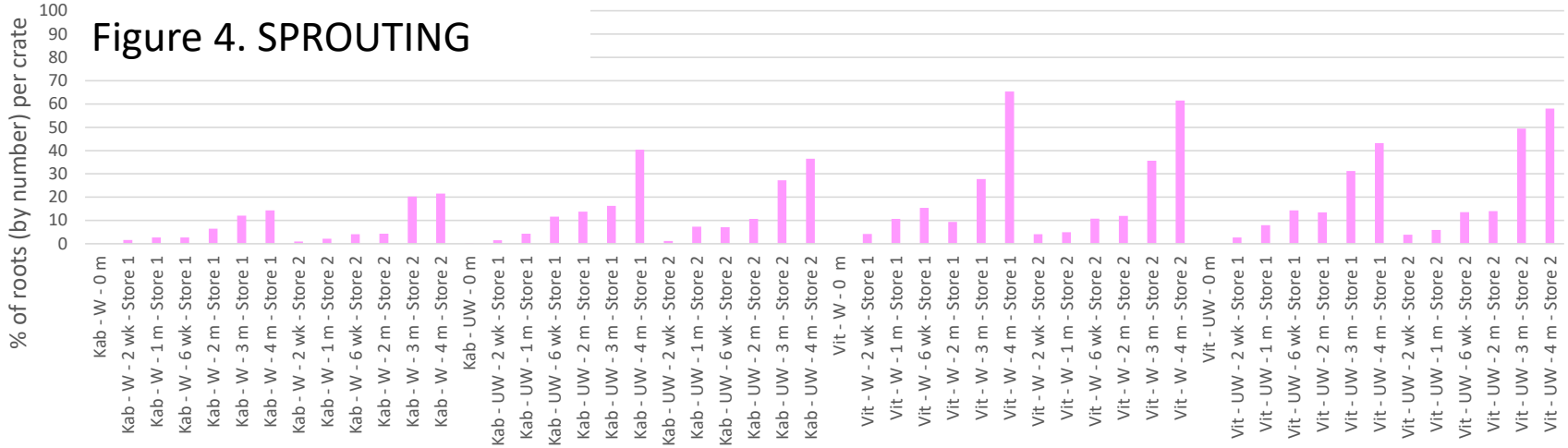
Figure 3. WEEVIL DAMAGE



Treatments & storage duration: Variety (Kabode, Vita), Soil removal (Washed, Unwashed), Store power (1 = Solar, 2 = Mains)

- Weevil damage increased with storage time, despite 3 rounds of sorting to remove weevilled roots before setting up the trial. Presence of weevil damage was higher in the mains powered store.

Figure 4. SPROUTING



Treatments & storage duration: Variety (Kabode, Vita), Soil removal (Washed, Unwashed), Store power (1 = Solar, 2 = Mains)

- % of roots with sprouts increased with storage time. Washed Kabode roots had least sprouting
- Less rotting (not shown) occurred in the Vita than the Kabode roots
- % weight loss (not shown) was lower in Vita than Kabode

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Findings (5/5)

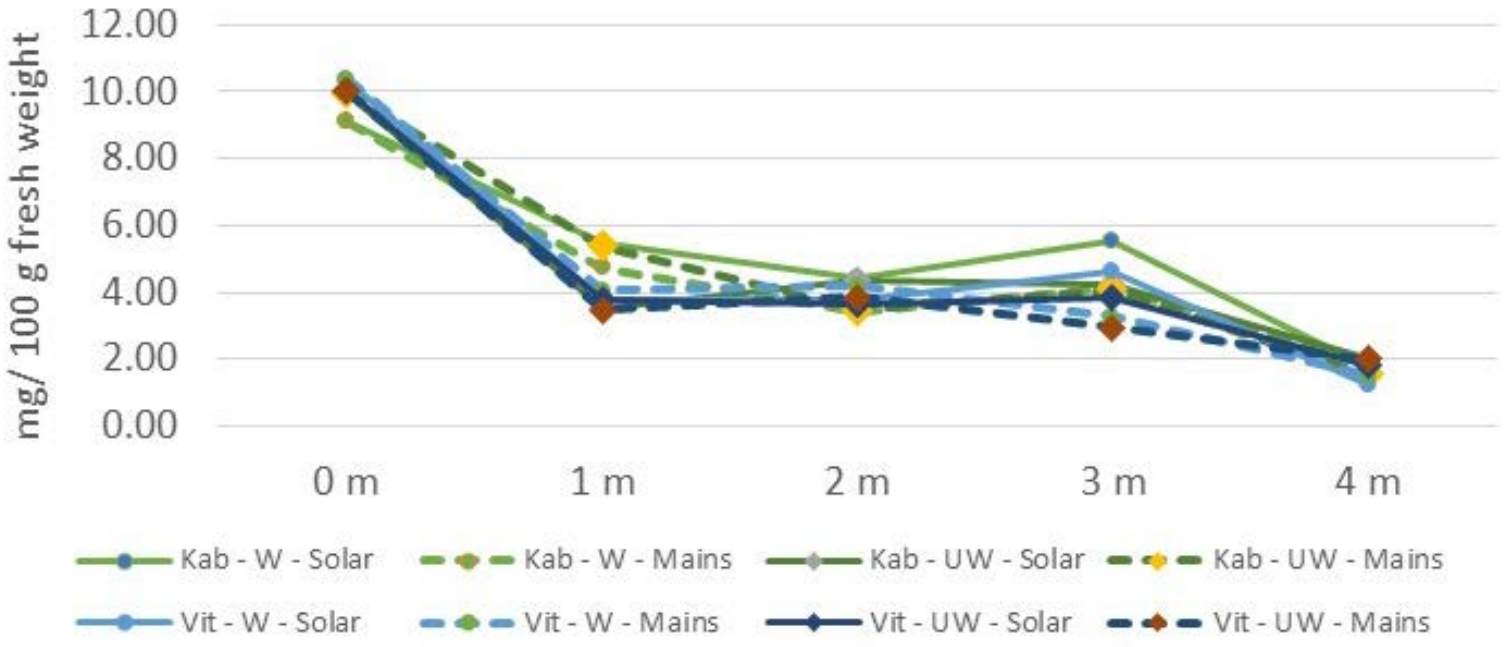

Figure 5: Trans beta-carotene content of stored raw roots over time (months)

- Trans beta-carotene content decreased rapidly in all treatments during the first 1 month of root storage, and then more slowly after that

Discussion points

- **Promising that >60% of Kabode root weight, and >80% of Vita root weight is fit for processing into puree after 4 months fresh root storage**
- Quality of Vita stored roots was generally higher than Kabode
- Manual washing plus sun-drying of sweetpotato roots prior to curing and storage did not significantly affect root quality
- Despite very extensive sorting of roots prior to storage some weevils still developed in the roots
- The drop in trans beta-carotene content of the roots suggests enzymatic activity occred under the current storage conditions
- In preliminary explorations, customers bought OFSP roots stored for 4 months highlighting fresh root marketing storage opportunities
- A solar-powered container store that can maintain 15C has now been designed by the NRI engineer, we are about to set up a trial to see if weevil damage, rotting, sprouting and trans beta-carotene reduction are lower at lower temps
- Storage loss levels strongly affect the economics of root storage and this topic needs further investigation

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