Cassava Post-harvest Deterioration: Towards Strategies for Solutions

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Overview

- What is post-harvest physiological deterioration (PPD)?
- Economic & social impacts of PPD
- Existing & potential strategies for control
- Strategies for solutions

What is post-harvest physiological deterioration (PPD)?

- Physiological / biochemical changes in the root (not due to micro-organisms)
- Becomes unpalatable and unmarketable within 24 - 72 hours of harvest
- Therefore, prompt consumption or processing necessary
- PPD is a major constraint to cassava production, processing and consumption
- Impacts on sustainable livelihoods of resource-poor farmers

Current understanding of PPD

- Active process involving changes in gene expression, enzyme activity & biosynthesis of low molecular weight compounds
- Parallels to:
  - Wound responses - except healing inadequate
  - Oxidative stress responses – activity of enzymes & compounds that modulate reactive oxygen species
  - Senescence responses – senescence-associated gene homologues expressed

Economic & social effects of PPD

- Significant wastage
  - e.g. 5-25 %, which ends up as animal feed
- Price reduction on deteriorated cassava:
  - e.g. 70-90% discounting on 3 day old cassava in Tanzania
- High mark-up on fresh roots, especially in urban markets
  - up to 60 % of final price
  - urban consumers choose other starchy foods
- Non-uniform input to processing & industry
  - reduces quality & competitiveness of cassava products

Therefore, controlling PPD would:

- Benefit small & large-scale cassava farmers
- Benefit urban consumers of cassava
- Benefit small & large-scale processors of cassava
- Reduce LDC imports of carbohydrate alternatives
- Make cassava products more competitive

Current & potential strategies for control

- Mechanical
- Breeding
- Biotechnological

Mechanical strategies

- Keep roots in field until required
- Pruning before harvest
  - But alters starch quality
- Processing into traditional & industrial products
  - Not all people consume processed cassava
  - Quality problems with large-scale processing
- Oxygen exclusion
  - Plastic bags – not adopted
  - Waxing – high cost
- Freezing
  - High cost

Breeding strategies

- Tried & tested means of crop improvement
  - Has worked well for some traits (e.g. yield) in cassava
- But:
  - Cassava's high heterozygosity complicates breeding
  - PPD is a complex polygenic trait
  - PPD correlated with high dry matter
  - Environmental factors complicate scoring for minor PPD differences
- However, quantitative trait loci (QTLs) & marker assisted selection (MAS) could help breeding

Biotechnological strategies

- Advantages:
  - Potential to introduce genetic constructs into any cultivar
  - Specific manipulation of genes of interest
  - Success in some major crops & model plants
- Disadvantages:
  - Largely untried in cassava
  - Cassava transformation is complex & so far limited to model cultivars

Relevant successful examples

- Anti-sense polyphenol oxidase reduces browning in wounded potato & apple (Coetzer *et al*., 2001; Murata *et al*., 2000, 2001)
- Cytokinin biosynthesis gene driven by senescence-associated promoter inhibits leaf senescence in tobacco (Gan & Amasino, 1995)
- Anti-sense polygalaturonase gene alters ripening in tomato (Gray *et al*., 1994)

Strategies for solutions

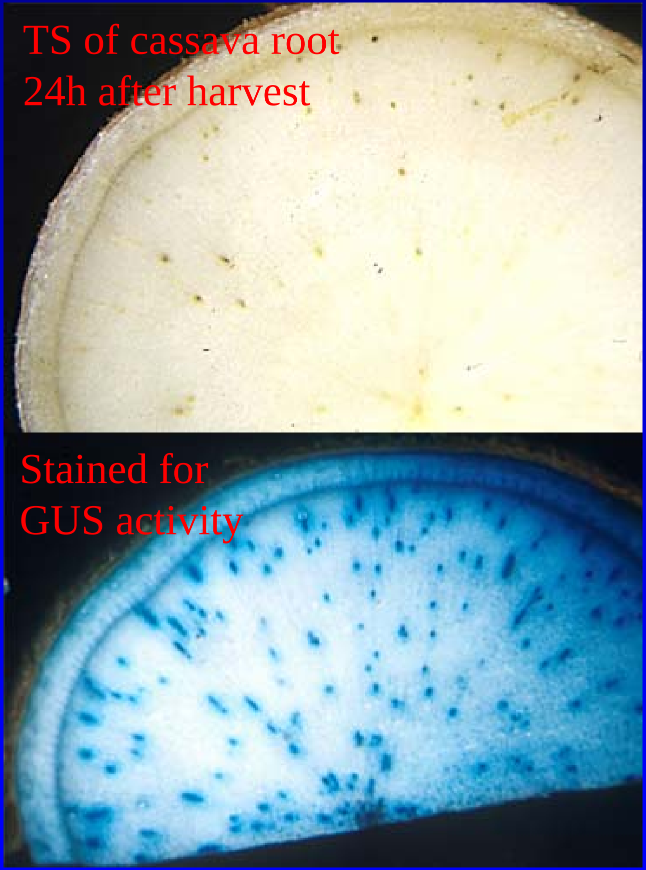
- Tools required:
  - Genes
  - Promoters
  - Transformation
  - Field testing
  - Collaborating laboratories
  - Legislation

Tools required: genes

- Evaluation of cassava germplasm, including exotic, can help in selection of material
- Identification & characterisation of all genes involved in PPD – e.g. via cDNA microarrays
  - Potential spin offs:
    - markers for genomics
    - identification of QTLs
    - input into breeding via MAS
    - synergistic interaction with breeding/genetics

Tools required: promoters

- Organ, tissue & PPD specificity important
- Timing of activity may be critical
- Required to drive sense &/or anti-sense constructs



840 bp cassava PAL2 promoter driving GUS in transgenic cassava

Tools required: transformation

- Efficient model system for testing candidate constructs in transgenic cassava
  - Current systems are complex, time consuming & cultivar dependant
  - Room for improvement
  - Dissemination of expertise
- System must be extended to farmers' preferred & elite cultivars
- Availability of appropriate vectors - biosafety

Tools required: field testing

- Experimental candidate constructs will need evaluation in green house & in field
- Transgenics for potential release will require full field testing in appropriate agro-ecologies

Tools required: collaborating laboratories

- Links & collaborations already exist:
  - Bath – PPD molecular biology & biochemistry
  - CIAT – germplasm, genomics, genetics, mapping, transformation, field testing
  - IITA – germplasm, genetics, mapping, field testing
  - ILTAB - transformation
  - Others?

Tools required: legislation

- Appropriate biosafety legislation required in target countries
- Influence & assist legislation process
- Approval of transgenic cassava varieties

Alfred Dixon:

- “Controlling PPD would turn cassava into a modern crop, unlocking its full potential for Africa and the world”
- Our challenge is to make Alfred’s words a reality

- Thanks