Cocoa waste to wealth using known yeast strains from Ugandan box fermentation

UNCST- Ntinda
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Presentation outline

• Background
• Problem statement
• Intervention and justification
• Objectives
• Methodology
• Expected outputs
• Project implementation plan and budget
• Expected outcomes
• Conclusion
Background

• Cocoa (*Theobroma cacao*) is ranked 4th foreign exchange earner in Uganda

• Uganda exported 28,000mt (2016)

• Cocoa supports over 10,000 farmers in Uganda.
Background cont’d

• Cocoa is grown for beans which are the major raw material for chocolate

• Cocoa pod contains approx 33% beans, covered by white mucilage rich in pectin and fermentable sugars

• Mucilage is fermented by yeast and bacteria to yield aroma precursors for chocolate.
Problem statement

• The storey boxes currently used for fermentation;
  • laborious
  • require intensive capital investment
  • require >100kg fresh beans

• Excludes women and other vulnerable groups
Problem statement...

• 1kg of dried cocoa beans produces 0.59kg of mucilage (cocoa sweating) (Carols et al., 2016)

• In 2016 Uganda lost 17,555 tonnes of cocoa sweatings rich in 8-9% fermentable sugars equivalent to 717.6 tonnes ethanol

• This sweating impacts the environment negatively

• NaCORI has isolated 24 yeast strains using culture dependent methods.
Research questions

• Does application of pectin degrading yeast increase the extraction rate of juice from cocoa pulp?

• Does single box fermentation improve the quality of cocoa beans and lower production costs?

• Are farmers willing to adopt the improved fermentation method?
Intervention

• Design a user friendly single fermentation box

• Design a cocoa pulp extraction tank facilitated by pectin degrading yeast

• Develop value added products from cocoa pulp (bio-ethanol and wine)
Objectives

• To study the diversity of pectinolyase producing yeast strains isolated from Ugandan box cocoa fermentation

• To design a stainless steel tank for cocoa pulp extraction and a wooden single cocoa fermentation box

• To develop value added products from cocoa pulp and sweating

• To promote farm level cocoa processing and local use of the by-products
METHODOLOGY
Conceptual framework

**OUTPUTS**
- Well fermented cocoa beans
- New products (ethanol and wine)
- Cocoa postharvest handling procedure

**IMPACT**
- Better prices
- Extra income to farmers
- Consistent quality and assured safety
- Environmentally friendly processes
- Better governance of the cocoa value chain

**PROBLEM**
- Underutilized cocoa waste;
- Laborious fermentation methods
- Poorly fermented cocoa beans with variable aroma

**PROCESS INNOVATION**
- Using known yeast starter culture to ferment cocoa;
- Modified fermentation process

**Research, farmers**

**Research, farmers and processors**

**Farmers, extension workers, society, government and policy**
Screening of yeasts for ethanol and pectinolyase production

- Yeasts will be evaluated for ethanol production using cocoa pulp simulation media (CPSM)
- The isolates will be screened for pectinolyase activity using orange pectin based media
- This work will be carried out at Makerere University, department of food technology and Biosciences lab, NaCRRI.
Developing value added products

• Designing a single fermentation box
  • A modification of the old storey fermentation box by designing a single box with a hand crank
• Designing of de-pulping stainless steel tank with a hydraulic press for juice extraction
• The extracted cocoa juice will be used to make bio-ethanol and wine using the isolated yeast strains
• Partners involved NaCORI, MUK, ICAM and Lwanga
Dissemination and knowledge utilization

This will be done using the following avenues:

• Training of trainers-agricultural extension officers (sub county level)

• Processors, farmer groups and cooperatives

• Print (Brochures, manuals and academic publication)

• Participatory impact project appraisal (PIPA) at the start, mid and end of project
Expected outputs

• At least 0.5 litre of a pectinolyase producing yeast starter culture
• One efficient cocoa pulp juice extraction procedure
• One innovative method for cocoa fermentation
• 2 value added products from cocoa pulp and sweating (Bioethanol and wine)
• 3 publications
• 10 cocoa extension officers trained in post harvest handling
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<th>Activity</th>
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<tr>
<td>Inception meeting for project partners and other stakeholders</td>
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<td>Selection of yeast that produce pectinolyase</td>
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<td>Design of juice extraction stainless steel tank and fermentation box</td>
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<td>On-farm cocoa fermentation trials</td>
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<td>Developing value added products from cocoa waste</td>
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<td>Training of cocoa extension officers</td>
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<td>End of project dissemination workshop</td>
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<td>Selection of yeast that produce pectinalyase</td>
<td>At least 0.5 litre of a pectinolyase yeast starter culture</td>
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<td>Design of juice extraction stainless steel tank and fermentation box</td>
<td>One efficient and environmentally safe cocoa pulp juice extraction procedure A Prototype of a single cocoa fermentation box</td>
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<td>Production of value added products from cocoa pulp juice</td>
<td>2 Value added products (ethanol and wine)</td>
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<td>Promoting on-farm level cocoa processing</td>
<td>10 Cocoa extension officers trained in PHH 3 policy briefs and publications Strengthened and well directed cocoa</td>
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<td><strong>TOTAL</strong></td>
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## Team composition

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<th>Name</th>
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<tr>
<td>Muganga Lawrence (Food scientist NaCORI, Msc Food science)</td>
<td>Principal Investigator (PI) and lead yeast isolation</td>
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<tr>
<td>A. N. Kaaya (Prof MaK, PhD Food scientist/Technologist)</td>
<td>Co-PI and lead in product development</td>
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<tr>
<td>Daphne N. Bitalo (Geneticist NaCORI, PhD genetics)</td>
<td>Selection and identification of yeast with pectinolytic ability</td>
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<tr>
<td>Mulindwa Joseph (Food scientist NaCORI, Msc food science)</td>
<td>Product development and branding</td>
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<tr>
<td>Obale Joseph (Bsc. Botany, agronomist ICAM)</td>
<td>On-farm demonstrations and technology dissemination</td>
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<tr>
<td>Lwanga Henry (Diploma Crop husbandry, farmer)</td>
<td>On-farm demonstrations and technology dissemination</td>
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<tr>
<td>Lwasa Stephen (PhD Agric. Economics, Lecturer Mak)</td>
<td>Techno-economic analysis (TEA) and participatory impact project appraisal (PIPA)</td>
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Projected outcomes

• A cost effective method for wine or ethanol production from cocoa pulp juice
• Product diversity from cocoa waste
• 25% increment income of participating farmers
• Continuity and support to cocoa research
Conclusion

• The project will minimize technical constraints along the cocoa value chain

• Quality control and assurance of the cocoa beans will be strengthened

• The project paves way for innovative methods for enhanced cocoa postharvest handling and development of commercial value added products from cocoa waste.