ASSESSING THE PROCESSES OF KITOZA: A TRADITIONAL MALAGASY MEAT PRODUCT
- AFTER project/European Union

- AFTER = African Food Tradition REvisited by Research

- AIMS AT improving the quality and safety of african traditional food
COORDINATOR: CIRAD - France

France (Actia, Adiv, CVG, Inra, Racines)
Italy (Spes)
Portugal (ESB)
UK (NRI)

EUROPE

Benin (UAC)
Cameroon (Ensai)
Egypt (FAAU, NRC)
Ghana (FRI)
Madagascar (UT)
Senegal (Ucad et Aafex)

AFRICA

South Africa (CSIR)
- **Kitoza: the only meat product**

- Traditional meat product of Madagascar
- Previously prepared for kings and nobles
- Made from beef or pork strips 20 to 50 cm long, 2 to 4 cm wide
- Salted and then sun-dried and/or smoked
- May be produced at household level
- Smoked kitoza in small scale shops
Previous results:

- Survey in Antananarivo and sampling: sun-dried and smoked beef or pork kitoza
- Physico-chemical and microbiological analyses on end products
- Sensory analyses and consumer acceptance studies (Poster)
- 3 smoked products chosen: 2 beef and 1 pork

**STEPS:**
- Recording temperature and weight in sites
- Establishing a synthetic traditional diagram
- Sampling at critical unit operations
- Assessing the impact of the process on product quality
Producer A (beef 1)

Raw material (beef)
100kg

Washing and cutting
20-30cm * 2-3cm
T°: 20-25°C, 13min

Strips
98.4kg

Ingredients adding
salt: 10g/kg; ginger: juice of 500g; oil: 50ml/kg
T°: 20-25°C, 3min
Marinating
T°: 4°C, 15min

SeASONED strips
100.9kg

Smoking
2h20min

Smoked kitoza
46.2kg

WaterLoss: 48kg/100kg

SaltGain: 1.0kg/100kg
Temperature ($^\circ$C) vs Smoking time (h)

- Smoking unit
- At the surface
- Core temperature
<table>
<thead>
<tr>
<th></th>
<th>Raw material</th>
<th>Strips</th>
<th>Seasoned strips</th>
<th>Smoked kitoza</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water wb (g/100g)</strong></td>
<td>76.1±0.6⁸</td>
<td>74.8±0.4⁸</td>
<td>74.3±0.7⁸</td>
<td>55.6±1.8⁹⁰</td>
</tr>
<tr>
<td><strong>Salt wb (g/100g)</strong></td>
<td>ND</td>
<td>ND</td>
<td>0.99±0.04⁸</td>
<td>1.61±0.14⁹⁰</td>
</tr>
<tr>
<td><strong>Aw</strong></td>
<td>0.990±0.001⁸</td>
<td>0.989±0.001⁸</td>
<td>0.984±0.003⁸</td>
<td>0.968±0.003⁹</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>5.59±0.16⁸,⁹</td>
<td>5.40±0.01⁸</td>
<td>5.54±0.06⁹,⁹⁰</td>
<td>5.72±0.02⁹⁰</td>
</tr>
<tr>
<td><strong>Glucose wb (g/100g)</strong></td>
<td>0.153±0.054⁸</td>
<td>0.222±0.028⁸</td>
<td>0.188±0.006⁸</td>
<td>0.209±0.021⁸</td>
</tr>
<tr>
<td><strong>Phenols wb (mg/100g)</strong></td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>2.10±0.25</td>
</tr>
<tr>
<td><strong>B(a)P wb (µg/kg)</strong></td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>6.92±1.18</td>
</tr>
<tr>
<td><strong>TAMF (log cfu/g)</strong></td>
<td>5.8±0.0⁸</td>
<td>5.1±0.0⁹⁰</td>
<td>5.8±0.1⁸⁰</td>
<td>2.4±0.1⁹⁰</td>
</tr>
<tr>
<td><strong>LAB (log cfu/g)</strong></td>
<td>5.5±0.1⁸</td>
<td>5.2±0.3⁸</td>
<td>5.5±0.2⁸⁰</td>
<td>2.2±0.2⁹⁰</td>
</tr>
<tr>
<td><strong>E. coli (log cfu/g)</strong></td>
<td>1.3±0.6⁸</td>
<td>&lt;1⁸</td>
<td>&lt;1⁸</td>
<td>&lt;1⁸</td>
</tr>
<tr>
<td><strong>Salmonella</strong></td>
<td>none/25g</td>
<td>none/25g</td>
<td>none25g</td>
<td>none/25g</td>
</tr>
</tbody>
</table>
Producer B (beef 2)

**Raw material (beef)**
- 100kg

**Washing and cutting**
- 20-30cm * 2-3cm
- $T^\circ$: 30°C, 70min

**Strips**
- 79kg

**Ingredients adding/marinating**
- Salt: 20g/kg
- Sugar: 20g/kg
- Ginger: 55g/kg
- Papaya: 30g/kg
- $T^\circ$: 30-40°C, 1h

**Seasoned strips**
- 89kg

**Smoking**
- 1h05min

**Smoked kitoza**
- 54kg

**SaG**: 1.7kg/100kg

**Chemical analysis**
- WaL (kg/100kg): 15.6, 25.8
- PhG (g/100kg): 0.4, 0.0
- BaP (mg/100kg): 0.1, 0.1
Smoking 1: wood

Smoking 2: charcoal

In the smoking unit at the surface
Core temperature

Temperature (°C)

Time (min)

In the smoking unit at the surface Core temperature
<table>
<thead>
<tr>
<th></th>
<th>Raw material</th>
<th>Strips</th>
<th>Seasoned strips</th>
<th>Smoking 1</th>
<th>Smoking 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water wb (g/100g)</td>
<td>77.0±0.6a</td>
<td>76.6±0.4a</td>
<td>74.9±0.5b</td>
<td>70.5±0.4c</td>
<td>61.9±1.3d</td>
</tr>
<tr>
<td>Salt wb (g/100g)</td>
<td>ND</td>
<td>ND</td>
<td>1.86±0.16a</td>
<td>2.13±0.15a,b</td>
<td>2.18±0.13b</td>
</tr>
<tr>
<td>Aw</td>
<td>0.989±0.001a</td>
<td>0.989±0.001a</td>
<td>0.976±0.000b</td>
<td>0.973±0.004b</td>
<td>0.968±0.002c</td>
</tr>
<tr>
<td>pH</td>
<td>5.74±0.16a,b</td>
<td>5.80±0.16a,b</td>
<td>5.81±0.03a,b</td>
<td>5.64±0.02a</td>
<td>5.87±0.07b</td>
</tr>
<tr>
<td>D-Lactic acid wb (g/100g)</td>
<td>&lt;0.014a</td>
<td>&lt;0.014a</td>
<td>&lt;0.014a</td>
<td>&lt;0.014a</td>
<td>&lt;0.014a</td>
</tr>
<tr>
<td>Glucose wb (g/100g)</td>
<td>0.080±0.029a,b</td>
<td>0.061±0.058a</td>
<td>0.164±0.038b,c</td>
<td>0.390±0.020d</td>
<td>0.195±0.080c</td>
</tr>
<tr>
<td>Phenols wb (mg/100g)</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>0.44±0.04a</td>
<td>0.40±0.04a</td>
</tr>
<tr>
<td>B(a)P wb (µg/kg)</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>1.70±0.07</td>
<td>2.06±0.21</td>
</tr>
<tr>
<td>TAMF (log cfu/g)</td>
<td>6.1±0.3a</td>
<td>6.6±0.2b</td>
<td>6.6±0.2b</td>
<td>5.5±0.1c</td>
<td>5.1±0.1d</td>
</tr>
<tr>
<td>LAB (log cfu/g)</td>
<td>5.4±0.3a</td>
<td>5.8±0.1b</td>
<td>5.9±0.1b</td>
<td>5.9±0.2b</td>
<td>4.0±0.1c</td>
</tr>
<tr>
<td>E. coli (log cfu/g)</td>
<td>3.7±0.8a</td>
<td>2.8±0.1b</td>
<td>2.9±0.3b</td>
<td>2.9±0.2b</td>
<td>&lt;1c</td>
</tr>
<tr>
<td>Salmonella</td>
<td>none/25g</td>
<td>none/25g</td>
<td>none/25g</td>
<td>none/25g</td>
<td>none/25g</td>
</tr>
</tbody>
</table>
Raw material (pork)
100kg

Washing and cutting
20-30cm * 2-3cm
T°: 20-25°C, 10min

Strips
100kg

Ingredients adding
salt: 15g/kg; four spices: 1.3g/kg; garlic:
11g/kg KNO₃: 0.8g/kg
T°: 20-25°C, 2min
Marinating

Seasoned strips
103kg

Smoking
45min

Smoked kitoza
58kg

SaG: 1.6kg/100kg

WaL: 28.2kg/100kg

Producer C (pork)
<table>
<thead>
<tr>
<th></th>
<th>Raw material</th>
<th>Strips</th>
<th>Seasoned strips</th>
<th>Smoked kitoza</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water wb (g/100g)</strong></td>
<td>73.5±0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69.8±1.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>63.5±0.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>62.8±0.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Salt wb (g/100g)</strong></td>
<td>ND</td>
<td>ND</td>
<td>1.57±0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.54±0.07&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Aw</strong></td>
<td>0.990±0.001&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.989±0.001&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.981±0.001&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.977±0.001&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>5.91±0.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.93±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.68±0.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.70±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>D-Lactic acid wb (g/100g)</strong></td>
<td>0.017±0.005&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>&lt;0.014&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.017&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>0.021±0.002&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Glucose wb (g/100g)</strong></td>
<td>0.069±0.019&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.081±0.012&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.136±0.019&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.169±0.003&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
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<td><strong>Phenols wb (mg/100g)</strong></td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>0.60±0.11</td>
</tr>
<tr>
<td><strong>B(a)P wb(µg/kg)</strong></td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>2.38±0.21</td>
</tr>
<tr>
<td><strong>TAMF (log cfu/g)</strong></td>
<td>7.3±0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.2±0.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.1±0.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.8±0.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>LAB (log cfu/g)</strong></td>
<td>6.5±0.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.2±0.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.3±0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.0±0.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>E. Coli (log cfu/g)</strong></td>
<td>1.7±0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.2±0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;b&lt;/sup&gt; (n=1)</td>
<td>&lt;1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Salmonella</strong></td>
<td>none/25g</td>
<td>none/25g</td>
<td>none/25g</td>
<td>none/25g</td>
</tr>
</tbody>
</table>
# Characteristics of end products

<table>
<thead>
<tr>
<th></th>
<th>Producer A</th>
<th>Producer B</th>
<th>Producer C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smoking:</strong></td>
<td>wood (2h20min)</td>
<td>wood/charcoal (1h)</td>
<td>charcoal/wood shavings (0h45)</td>
</tr>
<tr>
<td><strong>Water (g/100g wb)</strong></td>
<td>55.6 ± 1.8</td>
<td>61.9 ± 1.3</td>
<td>62.8 ± 0.3</td>
</tr>
<tr>
<td></td>
<td>1.61 ± 0.14</td>
<td>2.18 ± 0.13</td>
<td>1.54 ± 0.07</td>
</tr>
<tr>
<td></td>
<td>0.968 ± 0.003</td>
<td>0.968 ± 0.002</td>
<td>0.977 ± 0.001</td>
</tr>
<tr>
<td><strong>Salt (g/100g wb)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Aw</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Phenol B(a)P</strong></td>
<td>2.10 ± 0.25</td>
<td>0.40 ± 0.04</td>
<td>0.60 ± 0.11</td>
</tr>
<tr>
<td></td>
<td>6.92 ± 1.18</td>
<td>2.06 ± 0.21</td>
<td>2.38 ± 0.21</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>5.72 ± 0.02</td>
<td>5.7 ± 0.07</td>
<td>5.70 ± 0.01b</td>
</tr>
<tr>
<td><strong>Pathogenic germs</strong></td>
<td>&lt;Detection Threshold after smoking</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
POINTS OF THE PROCESSES TO BE IMPROVED
• Good practices of hygiene not respected:
  - Tools not disinfected
  - No cold chain,…

• B(a)P (PAH) content > 5 µg/kg for some end products
  (< 2 µg/kg for B(A)P in 2014 according to European regulations, EC 835/2011)
• End products shelf life not guaranteed after 2 or 3 days
- pH ≈ 5.8
- Aw ≈ 0.93
- No packaging

- No microbiological stability for final products
Reengineering suggestions for local market development
Improving the drying and smoking step

Increasing the shelf life by:

Optimizing temperature and duration:
- water content and Aw reduced
- same water, salt and phenol contents for all products

Using charcoal and/or wood shavings:
- PAH content reduced
Testing the storage of reengineered products at:
- room temperature
- 4°C
- 4°C under vacuum

by comparing:
- microbiological contents (TAMF, LAB, pathogenic flora)
- shelf life (DLC)

Sensory analyses
AMONG AFTER PROJECT OBJECTIVES:

- Promoting kitoza to new consumers
- Prospecting new markets (European)

- Madagascar is not included in the export positive list of meat products to the EU (Food Law EC 178/2002, EC 2073/2005 and POAO EC 853/2004)
Reengineering suggestions to comply with European market constraints
 Production Kitoza (beef and pork) in Europe with a view to commercializing in european territory

 Use of air conditioned system to control the cold chain throughout the process

 Automating the smoking unit in order to control the drying-smoking and the PAH content

 Packaging the end products under vacuum or protective atmosphere to improve the shelf life
- Studies on going:
  - Adapting diagrams and manufacturing processes to the technical means available on the european territory
  - Determining suitable packaging for end products
  - Applying biopreservation starter (pork kitoza) with a view to increasing shelf life

- Sensory analyses to be done
Conclusion: Process flow diagram for EU reengineering

1. Raw meat
2. Mechanical cutting into strips
3. Salting + spices + Biopreservation starters
4. Rest 4°C / 15min
5. Strong drying and smoking
6. Fast cooling
7. Under vacuum
8. Storage 4°C

Temperature, Hygrometry, Duratton monitored

12°C
ACKNOWLEDGMENTS
Thanks to PRODUCERS
THANK YOU FOR YOUR ATTENTION
THANK YOU FOR YOUR ATTENTION