**Background**

- Childhood malnutrition causes
  - Increased risk of chronic diseases (e.g. cancer in adulthood)
  - Impaired immunity
  - Impaired cognitive skills

- 90% of chronic disease deaths occur in low & middle income countries
  - Obesity high among urban poor; malnutrition high in rural children

**Inflammation and Chronic Disease**

- Cancer
- Cardiovascular diseases
- Pulmonary diseases
- Inflammation e.g. NF-kB, COX-2
- Neurological diseases
- Autoimmune diseases
- Reactive Oxygen Species
- Arthritis
- Weak Immune System
- Diabetes II

**Project PI**

- USA
  - Dr. Susanne Talcott – Nutritionist/Toxicologist
  - Dr. BB Singh – Cowpea breeder
- Zambia
  - Dr. John Shindano
  - Dr. Munyinda
- Kenya
  - Dr. Abdul Faraj,
  - Dr. Prisca Tuitoek
- South Africa
  - Dr. Amanda Minnaar
  - Dr. Gyebi duodu
**Background**

- Pulses known for nutritional properties: high proteins, fiber, low GI, low fat
- Evidence suggests pulse consumption provides health benefits against CVD, cancer, diabetes, etc
- Cowpea provides tremendous opportunity
  - Drought tolerant
  - Low input
  - Short maturity

**Project goal and opportunities**

- Position cowpea as a healthy food that can contribute to chronic disease prevention
  - Stimulate demand for food use among rural and urban populations
  - Influence favorable government policies, e.g., cowpea in school lunch programs
- Build sustainable cowpea value chain infrastructure

**Activities – screening for bioactives**

- Cowpea seed coat color used as primary phenotypic trait

**Activities – chemical characterization**

- Cultivate in uniform environment for analysis
**Activities – effect of processing**

- Phenolic content
- Antioxidant properties
- Composition - UPLC-MS

- Soak
- Boil
- Freeze-dry
- Extract

**Structural identification of bioactive compounds**

- UPLC-MS/MS profiling

**Activities – assess biomarkers of health**

- Establish potential of cowpea polyphenols to reduce inflammation and oxidative stress in non-malignant cells

**Activities – genetics of bioactive traits**

- Cross lines of interest
- Analyze parents & progeny

Leo (left, Kenya) and Twambo (Zambia) hard at work [at TAMU]
**Important findings**

- Seed coat color affects phenolic content
- Seed coat color affects antioxidant activity
- Processing has minimal effect on phenolic content
- Processing has minimal effect on antioxidants

**Fig.** Effect of micronisation of preconditioned and cooked cowpeas on protection against copper-induced LDL oxidation
Major findings

Seed coat color major determinant of flavonoid composition

<table>
<thead>
<tr>
<th>Major flavonoid</th>
<th>Red</th>
<th>Cream (light brown)</th>
<th>Black</th>
<th>Golden brown</th>
<th>Green</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavan-3-ols</td>
<td>High</td>
<td>Highest</td>
<td>Medium</td>
<td>High</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flavonols</td>
<td>Highest</td>
<td>Low-Med</td>
<td>low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Anthocyanins</td>
<td>-</td>
<td>-</td>
<td>Highest</td>
<td>Medium</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Cowpea extracts inhibit intracellular Reactive Oxygen Species production in CCD-18 colon epithelial cells...
Nuclear Factor kappa B (NF-κB)

- Activated form of NF-κB induces inflammatory disorders

Tumor Necrosis Factor (TNF-α)

- Causes chronic inflammation and proliferative signaling

Vascular Cell Adhesion Molecule (VCAM-1)

- Key role in tumor development

Relative Potency

- So how much cowpea?

Amount of cooked grain needed to obtain 10 μg/mL extract from selected cowpea varieties
**Summary - Scientific**

- Cowpea has several **bioactive compounds** that are absent in other pulses
- Cowpea has **excellent antioxidant and anti-inflammatory properties**
- **Seed coat color** affects flavonoid composition and specific bioactive pathways

Observed effects are relevant to **oxidative stress, chronic inflammation in cardiovascular disease, diabetes, malnutrition, cancer, intestinal inflammation**

**Capacity building**

- **Twambo Hachibamba** – PhD candidate, Zambia
- **Manpower training**, Egerton, Kenya
- **Manpower training**, UP, South Africa
- Leo Ojwang, PhD candidate, Kenya

**Stakeholder consultation**

Kenya 2011
**Future Steps – Health Benefits Trials**

Confirmation of *in vitro* data in animal models:
- In immune-deprived mice (relevant to immune status of malnourished children)
- In rats with chronic inflammation (relevant to obesity and inflammatory disorders)

**Future Steps – Human Clinical Trials**

- In school age children; effect of regular consumption of cowpeas on immune status and susceptibility to infections
- Pilot trials in an adult obese or diabetic population in Africa, and the US

**Future Steps – Breeding**

Next steps
- Heritability of bioactive traits; goal to enhance health properties of *locally desirable phenotypes*

**Future Steps – Implementation and impact**

- Engage key policy-makers to promote adoption of findings
- Engage stakeholders & collaborators – creative nutrition education for vulnerable groups
- Planning the development of *value-chains* in cowpea production
- Publishing research results in international peer reviewed journals [*a powerful advertising forum*]
Cowpea in the Limelight

- Anti-inflammatory properties of cowpea: Best graduate research competition winner at the American Association of Cereal Chemists Int’l Meeting, Palm Springs, CA October 2011
- **Cowpea is tasty**; cowpea-based chips and crackers won 2nd and 3rd Prizes, student product development competition at the AACCI Meeting, Palm Springs, CA 2011 [all judges were major industry executives]
- Need to continue exploiting such exposure opportunities - spark industry and consumer interest

Key personnel

- **Zambia**
  - John Shindano,
  - Chitundu Kasase
  - Munyinda
- **Kenya**
  - Abdul Faraj,
  - Prisca Tuitoek,
  - Rose Wangari; Macharia
- **South Africa**
  - Twambo Hachibamba (PhD student)
  - Alice Nderitu (PhD student)
  - Amanda Minnaar
  - Gyebi duodu
- **USA**
  - Leonard Ojwang – (PhD candidate)
  - Archana Gawde – PhD candidate
  - Susanne Talcott – Nutritionist/Toxicologist
  - BB Singh – Cowpea breeder
  - Jeff Ehlers – Cowpea breeder