



International Symposium on Assessing the Economic Impact of Nanotechnology

Session Two: Exploring the qualitative dimensions of the economic impact of nanotechnology

Assessing the breadth of the potential Economic Impact of Nanotechnology

Applications: Food & Food Packaging

Victor Bertucci Neto

Researcher Embrapa Instrumentação

São Carlos, SP, Brazil

www.embrapa.br , www.cnpdia.embrapa.br, victor@cnpdia.embrapa.br

Washington, DC, 26-27 March 2012



Embrapa – Current Perspective

Established in 1973
(model of private company,
but public owned)
Employees: 8,916
Total Scientists: 2,000+
Budget-2011: US\$ 1,2 billion



46 Research Centers

16 National Commodity Centers

16 Ecorregional/Agroforestry Centers

13 National Thematic Centers



Ministry of
Agriculture, Livestock
and Food Supply



Embrapa Research Centers

Embrapa

Headquarter

◆ 13 Thematic Centers

▲ 16 Commodities/product

■ 16 Ecorregional and forestry

● 03 Special Services



Ministry of Agriculture, Livestock and Food Supply



Brazilian Tropical Agriculture: before 1970's

- Low Ag Production (few itens)
- Low Productivity
- Yield Shortages, Food Supply Crisis
- Expensive Food, Inflation, Poverty
- Inadequate Ag Public Policies
- Lack of Specific Knowledge about Tropical Ag
- Institutional void (ag research, education, markets, media and governmental agencies, etc)

THE TASK: TO MOVE FROM AGRICULTURE APPLIED TO THE TROPICS TO TROPICAL AGRICULTURE



Ministry of
Agriculture, Livestock
and Food Supply



Outcomes

- Public policies
- Institutional building
- R&D to foster knowledge in tropical agriculture

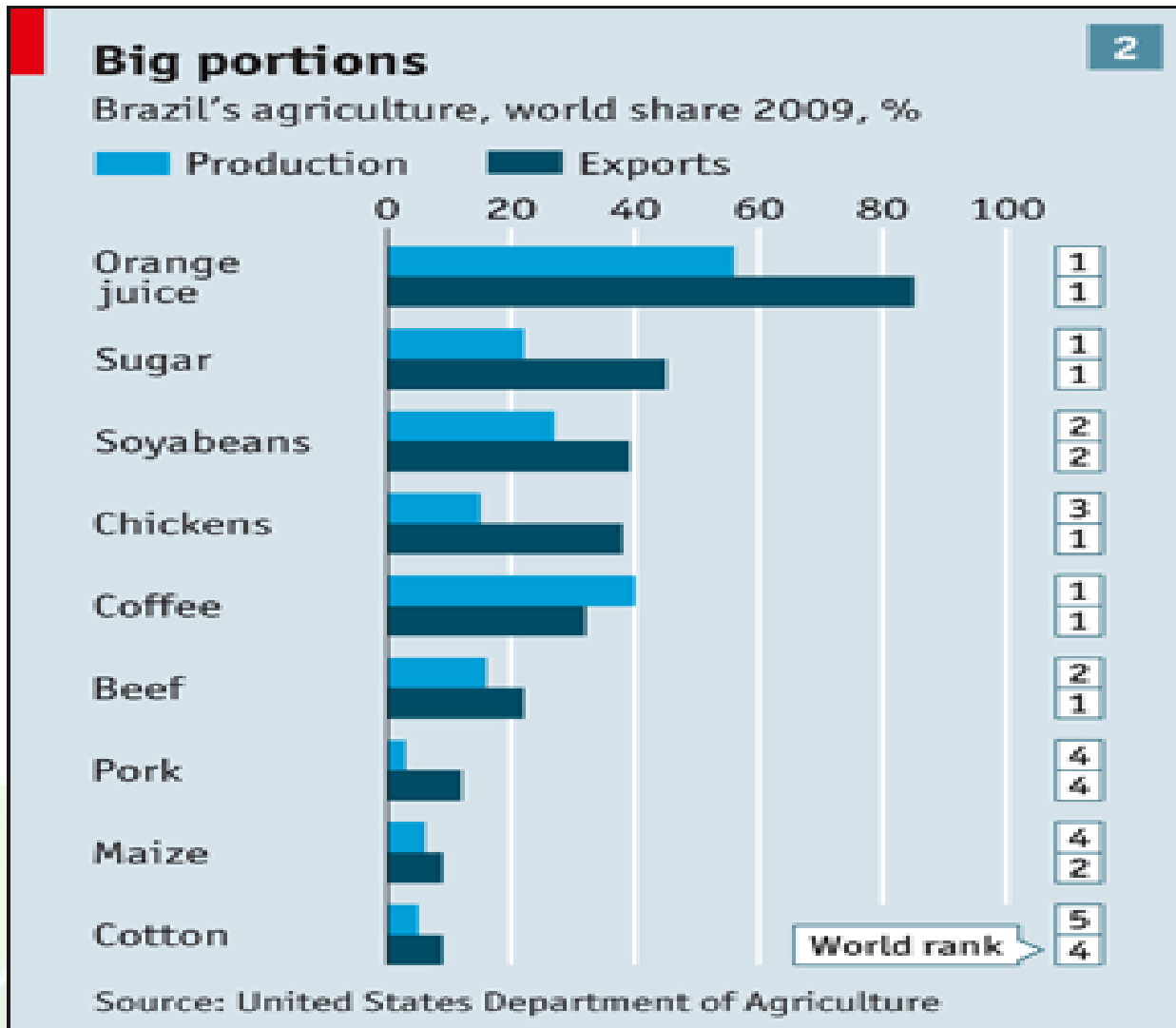


Embrapa

Ministry of
Agriculture, Livestock
and Food Supply

BRAZILIAN GOVERNMENT
BRASIL

Agricultural Production



**Leading exporter in
Agricultural Products
Brazil 2th place
(after USA)**



Ministry of
Agriculture, Livestock
and Food Supply



International Cooperation

Bilateral Cooperation

- Institutes, Universities
- Labex USA (North America)
- Labex Europe
- Labex Korea (Asia)
- Embrapa Americas (Panama-new)
- Venezuela- Office TT
- Embrapa Africa (Ghana)

Multilateral Agreements

- CGIAR
- PROCIS–Procisur, Procitrópicos

Reverse LABEX



Ministry of
Agriculture, Livestock
and Food Supply



- In 1984 was established the National Instrumentation Centre for Agriculture, Embrapa Instrumentation, São Carlos, São Paulo State.
- National Nanotechnology Laboratory for Agriculture (LNNA) - 2008



Ministry of
Agriculture, Livestock
and Food Supply



Macroprogram 1 Brazilian National Challenges Network Project

Nanotechnology applied to Agribusiness

1st Period: **2006 - 2010**

2nd Period: **2011 - 2014**

Embrapa Instrumentation



Ministry of
Agriculture, Livestock
and Food Supply





- 1st Period (2006-2010) focused in [building the capacity \(the research network\)](#) in 3 main areas:
- - **Sensors and biosensors for applications in food and agriculture**
- **Films and coatings for food package and direct coating in foods (edible films)**
- **New applications in agriculture-based materials (fibers, residues, etc)**



Ministry of
Agriculture, Livestock
and Food Supply



- 2nd Period (2011-2014) focused in [expanding the research network and incorporating of new research](#) in 6 main areas:
 - **Sensors and biosensors**
 - **Thin films for packing and edible coatings**
 - **Bionanocomposites**
 - **New applications for conventional nanomaterials (inorganic nanoparticles and coatings, etc) in agribusiness**
 - **Safety and toxicological aspects of Nanotechnology**
 - **Technology transference for the private sector and society in Nanotechnology**



Ministry of
Agriculture, Livestock
and Food Supply



Cellulose Nanofibers: from different sources



1-white and colored cotton



2-curauá



3-sisal

4- sugarcane bagasse

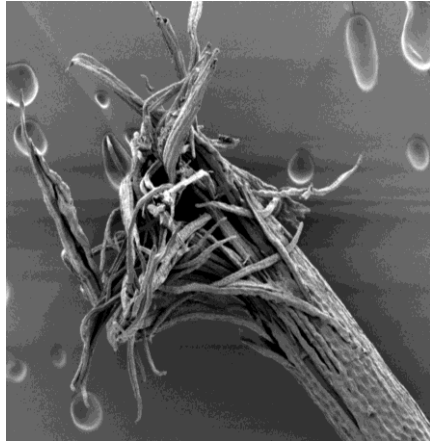


5- coconut fiber waste

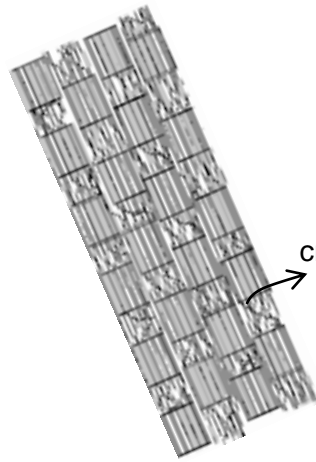


Cellulose nanowhiskers from coconut fiber (CNPAT)

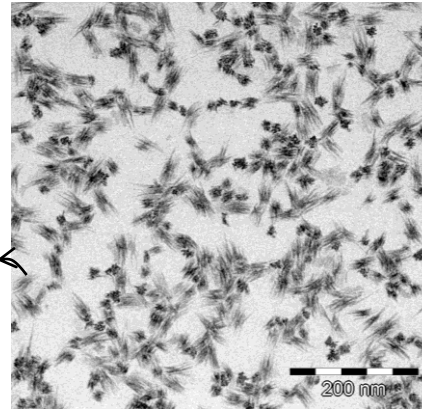
□ SEM / TEM



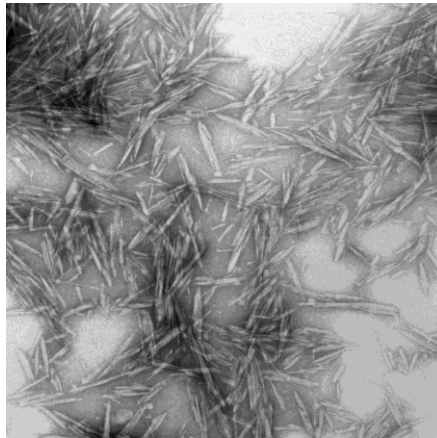
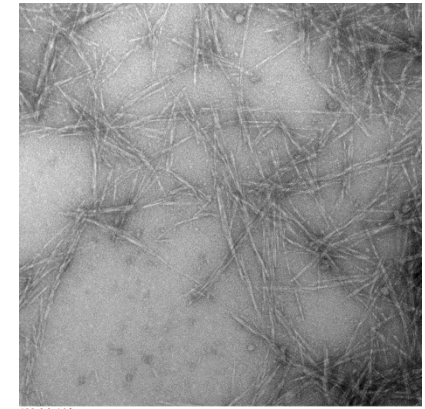
bleached coconut fiber



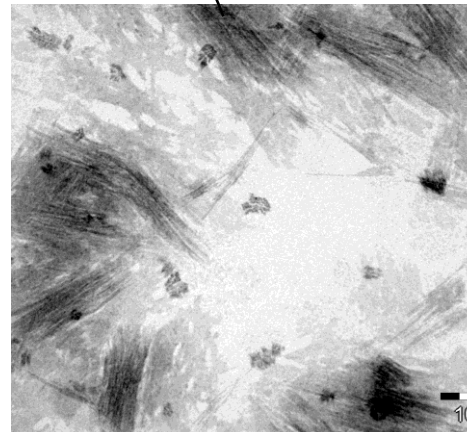
cristalite



nanowhiskers
coir - T1 (90 min)



nanowhiskers
cotton - T1 (90 min)



nanowhiskers
coir - T2 (120 min)

nanowhiskers from coconut

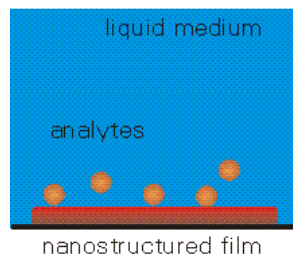
- different shape
- length: 100 – 500 nm
- diameter: 4 – 6 nm
- aspect ratio ~ 28

nanowhiskers from cotton

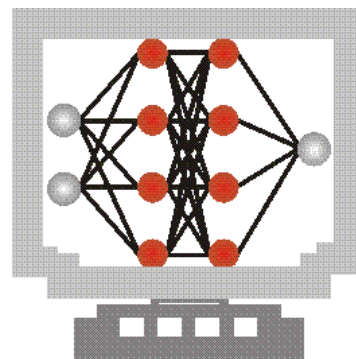
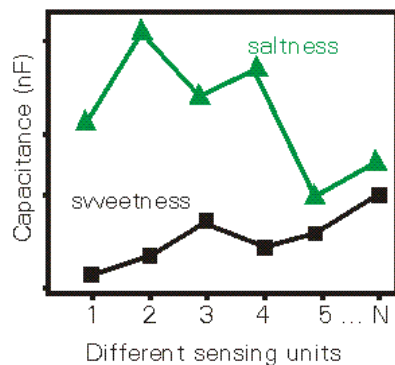
- aspect ratio ~ 10

“Electronic tongue”

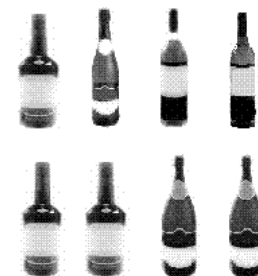
Analytical Chemistry, 2003



signal transduction



data processing
Artificial Neural Networks



simple, rapid
reversible monitoring
sample recognition
Quality Control

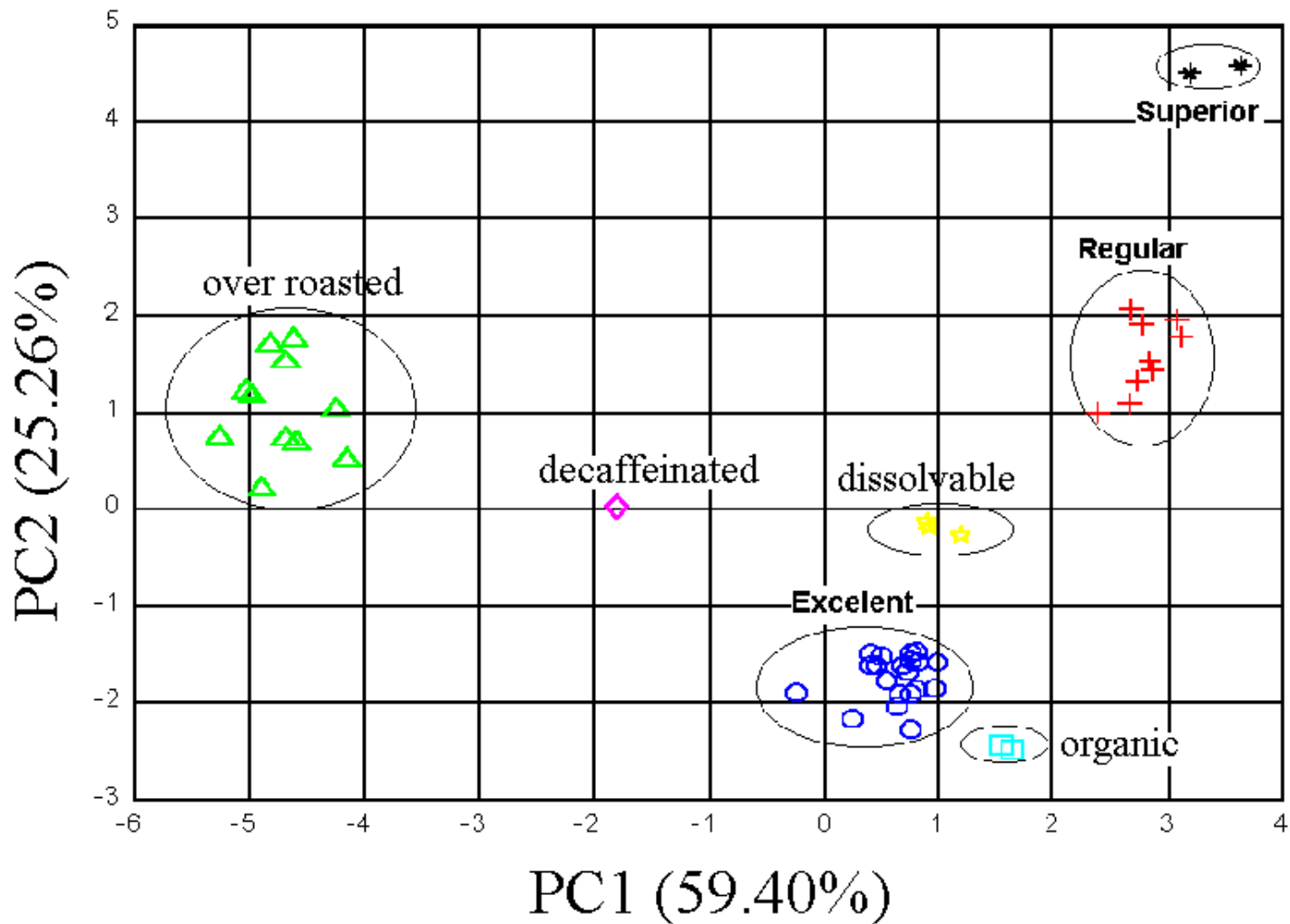
“Fingerprint” of the taste



Ministry of
Agriculture, Livestock
and Food Supply



Tasting coffees (electronic tongue)



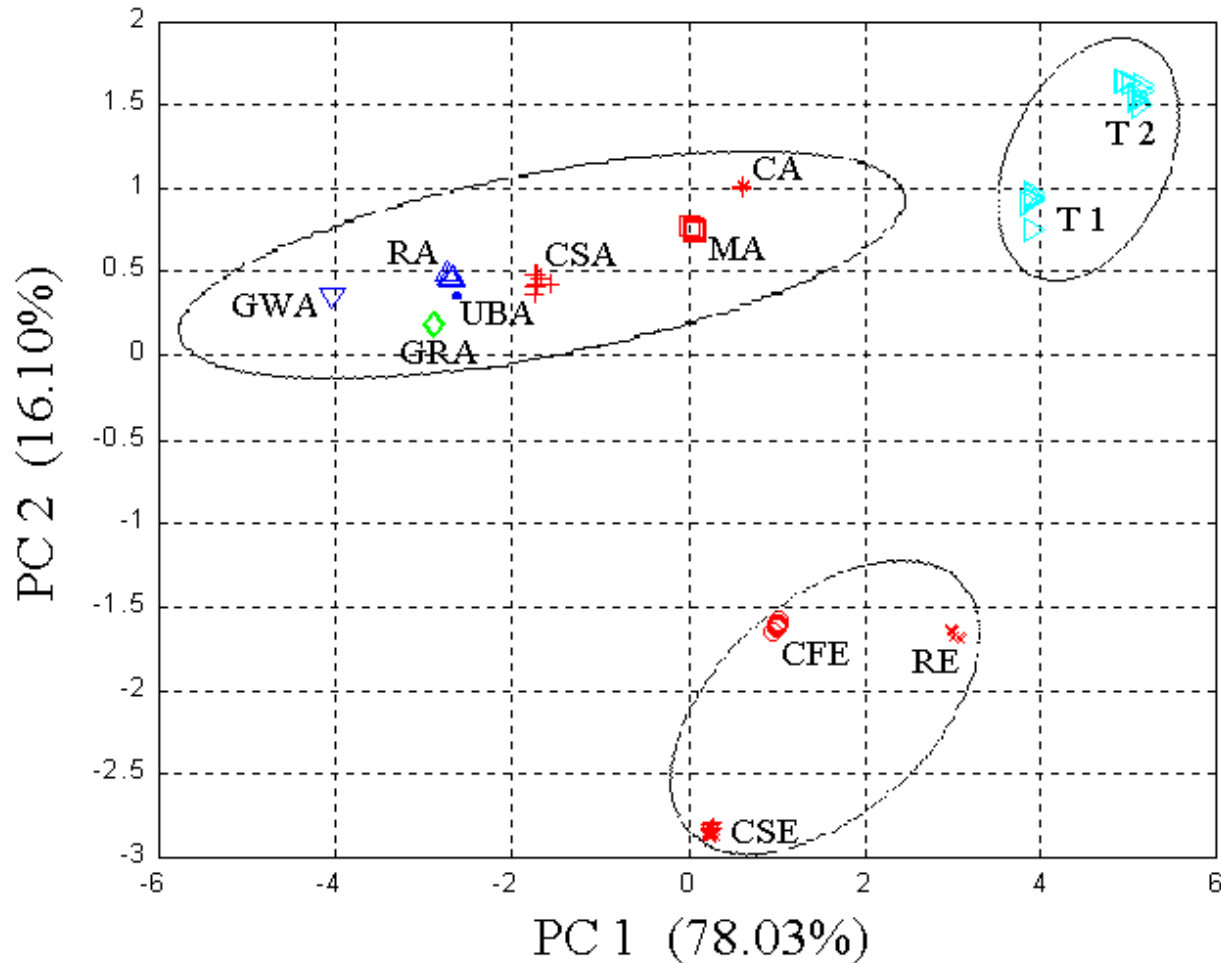
AGRICULTURAL RESEARCH - INNOVATION - QUALITY OF LIFE



Ministry of
Agriculture, Livestock
and Food Supply



Wines from different vineyards (electronic tongue)



CSA Cabernet Sauvignon A

CA Cabernet A

MA Merlot A

GRA Gammay Rosé A

RA Riesling A

GWA Gewürztraminer A

UB Ugni Blanc A

**CSE Cabernet Sauvignon
Embrapa**

CFE Cabernet Franc Embrapa

RE *Blend* Embrapa

T1 Table wine 1

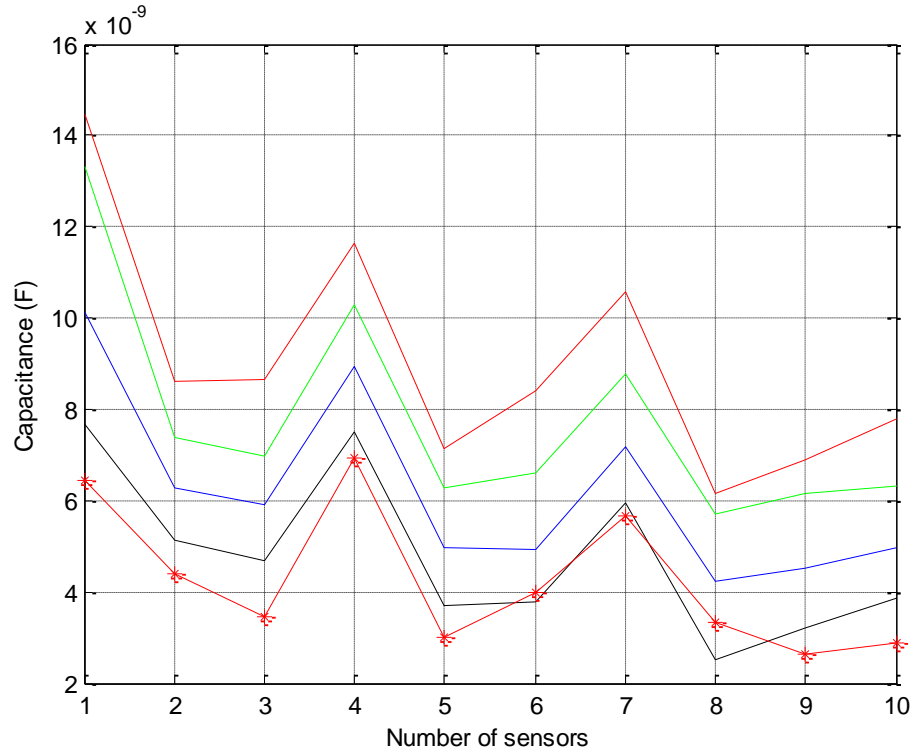
T2 Table wine 2



Ministry of
Agriculture, Livestock
and Food Supply



Detection of Microcystin



Capacitance variation on each sensor under different concentrations of Microcystin:
150 µg/L (red); 100 µg/L (green); 80 µg/L (blue); 20 µg/L (black); water (red+star)

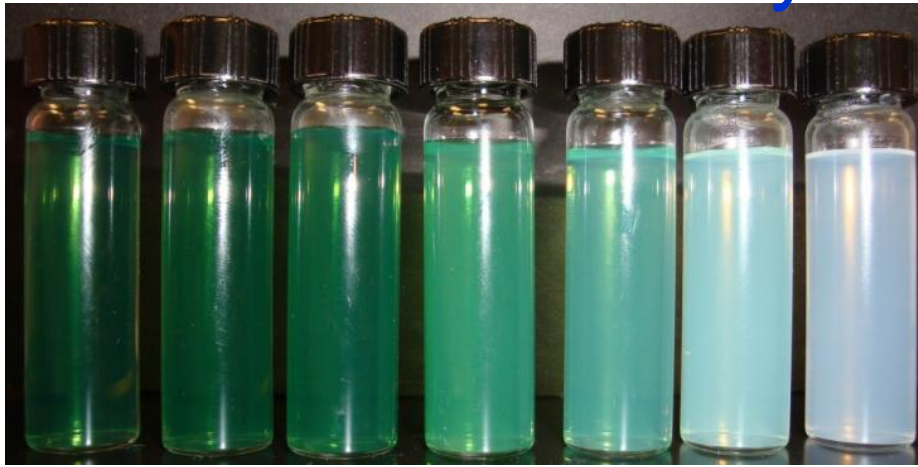


Embrapa

Ministry of
Agriculture, Livestock
and Food Supply

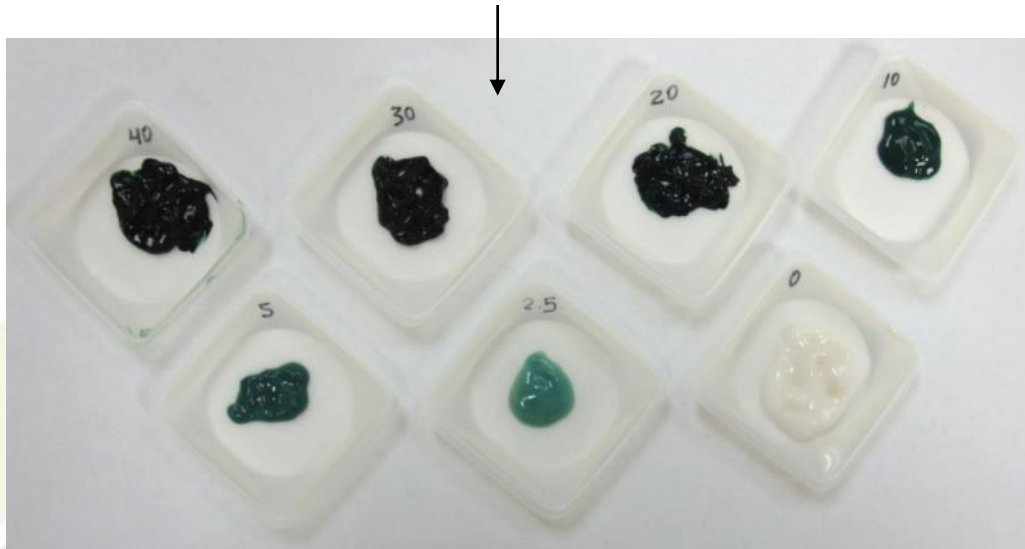
BRAZILIAN GOVERNMENT
BRASIL

Cellulose & Polyaniline Nanocomposite

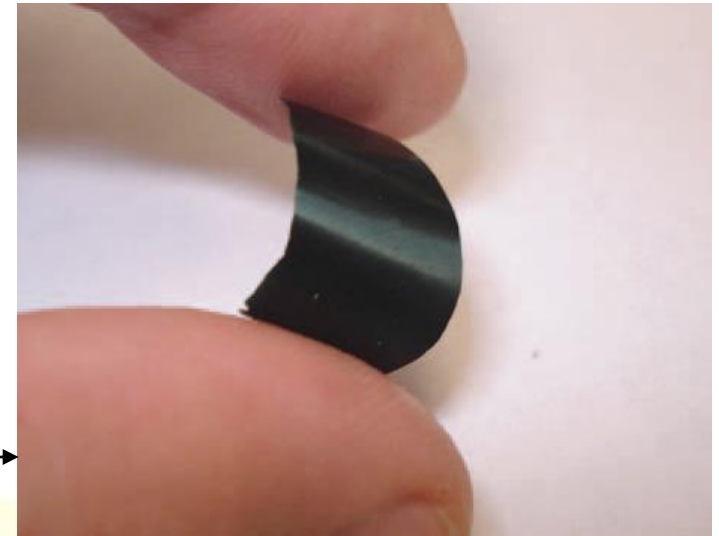


40 30 20 10 5 2.5 0 % Pani/CnF

Electrically conductive nanocomposites made from cellulose nanofibrils and polyaniline. U.S. Patent App. 2010 (Medeiros, Mattoso, Orts)



Conductive gels



Flexible self-standing films

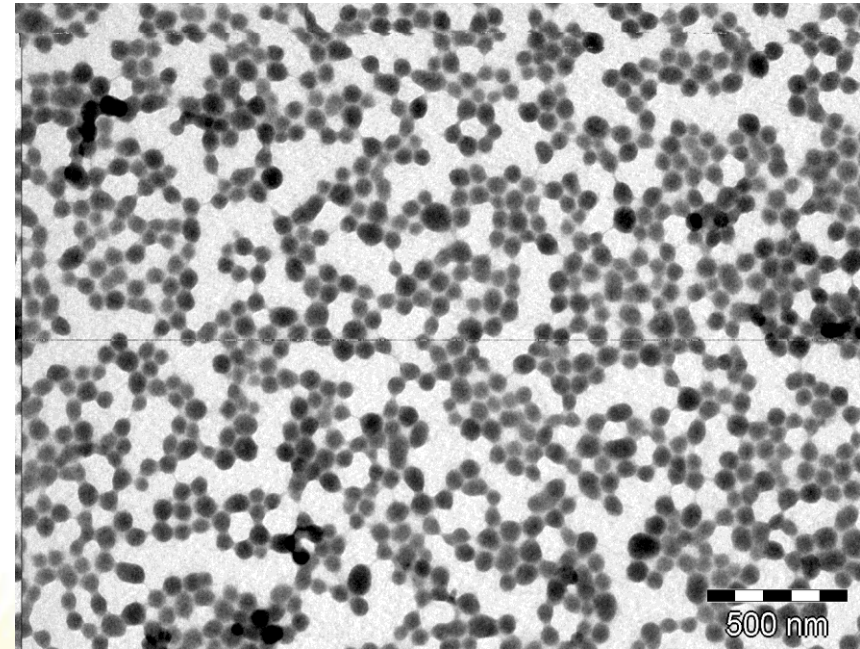
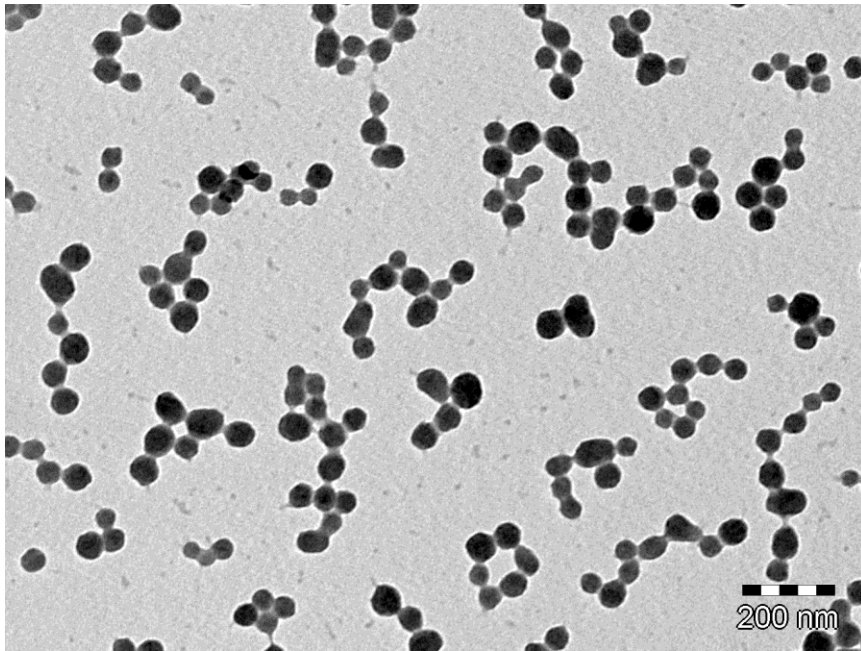


Embrapa

Ministry of
Agriculture, Livestock
and Food Supply

BRAZILIAN GOVERNMENT
BRASIL

Nanoparticles of natural polymers (chitosan, pectin, starch)



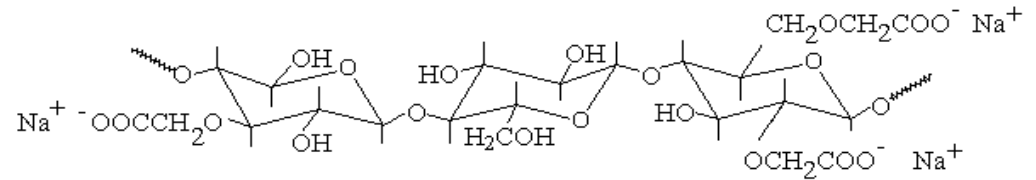
**Application: packaging, antimicrobial,
strength reinforcement, controlled release**



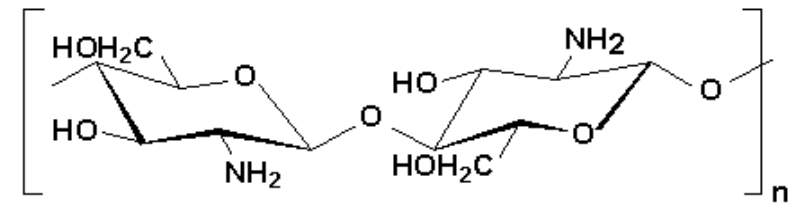
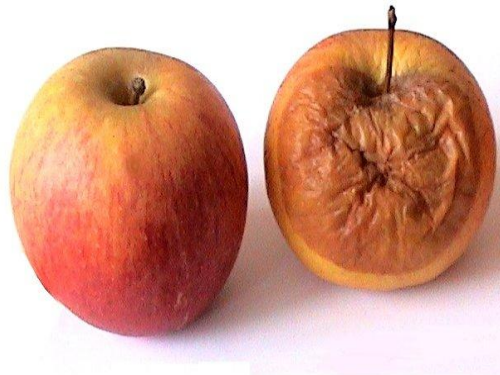
Ministry of
Agriculture, Livestock
and Food Supply



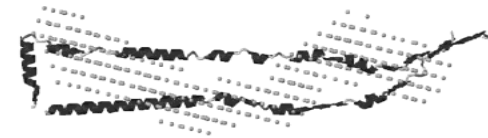
Edible Films: biopolymers directly applied in food to modify surface properties



Carboxymethylcellulose



Chitosan



Zein

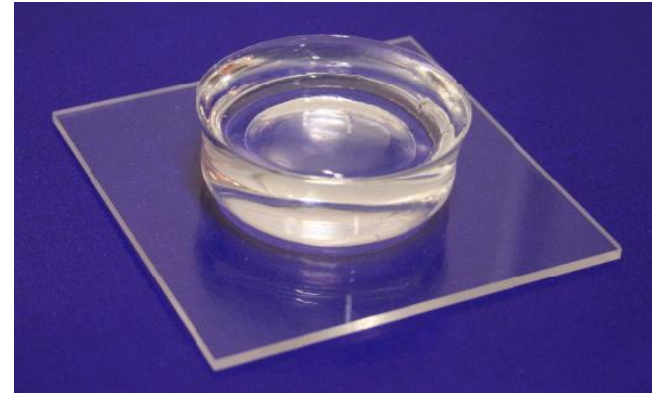
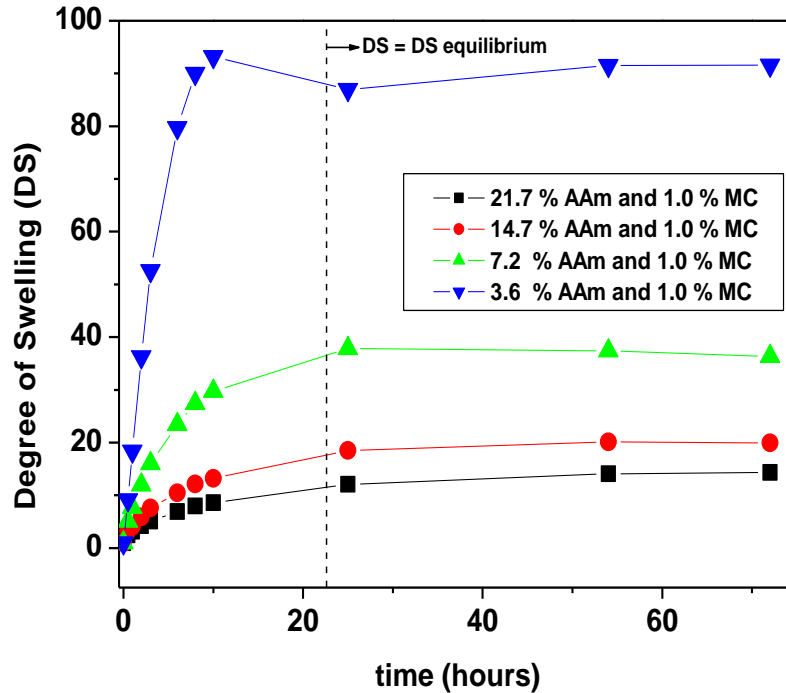
Credits: Embrapa Instrumentation
(Dr. Odílio B. G. Assis)



Ministry of
Agriculture, Livestock
and Food Supply



Hidrogel: controlled release



Swelling curves of PAAm-MC hydrogels in a pH ~ 7.0 at 25 °C.
Cooperation, Embrapa/USDA/UEM

DS= swollen mass /dry mass, values between 10 – 100 *
* 1 g of dry hydrogels ⇒ 100 g of water-uptake

Methyl Cellulose improves
water-uptake



Ministry of
Agriculture, Livestock
and Food Supply



Currently under developing:

- Electronic nose (quantify ethylene gas concentration in mature fruits)
- Genetic bar code for algae species



Ministry of
Agriculture, Livestock
and Food Supply



Impact and nanotechnologies in Embrapa:

Embrapa is forming a big team in Brazil and is leading this theme related to agriculture.

Basically are considered two situations:

-Economic impact (easier to be calculated)

Chain value and all the related tools

-Social/environmental impact (for the moment is subjective)

interviews with the chain value actors such as rural or industrial producers; new technology adopters, or users; society in general.

All the questionnaire responses are scored and weighted by the interviewer (the subjective action).



Ministry of
Agriculture, Livestock
and Food Supply



- **Nanotechnology applied in agribusiness is one of the areas that Brazil can be highly competitive.**
- **It can bring revolutionary solutions or improvement from the upstream to the downstream of the value chain.**
 - **Nanosensors applied in the whole value chain, nanocatalyzers (intended to diagnose plant diseases), molecular treatment in plants, improvement of nutrient and fertilizer absorption, nanocomposites applied to packages and new materials, nanodevices for traceability, etc.**



Ministry of
Agriculture, Livestock
and Food Supply



Thank you for your attention!



Ministry of
Agriculture, Livestock
and Food Supply

