Nanocellulose : applications in food?

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Nanocelluloses and food

Nanocellulose research and applications are almost exclusively dedicated to non-food applications

However, to be fully enlarge, the market of NC should be extended to all kind applications

What applications in food sector for nanocellulose?

- Already existing uses of nanocellulose in food : bacterial cellulose
- Tehchnological properties of NC : thickening, gelling and water binding agent, emulsions.
- New applications ?

What are the limitations?

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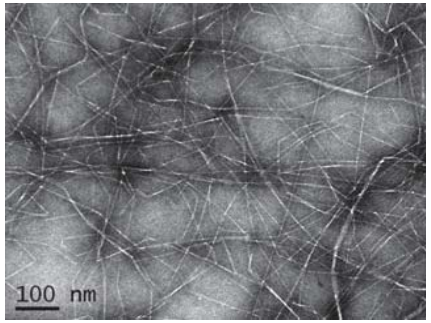
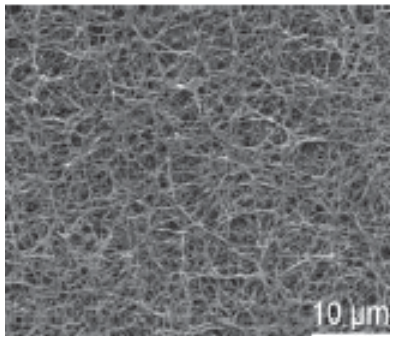
Nanocelluloses

Cellulose nanofibrils (CNF)

1) TEMPO oxidation or enzymatic pretreatment
2) Mechanical treatment



Cellulose : wood, cotton, alga, ….

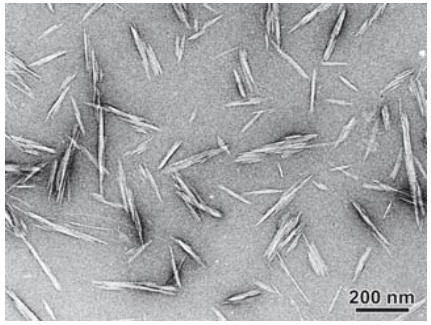


Bacterial cellulose (BC)

Fermentation

Low molecular weight sugars, alcool, ….

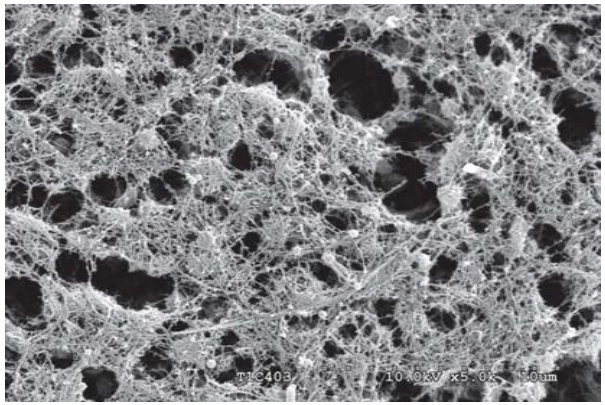
Acid hydrolysis

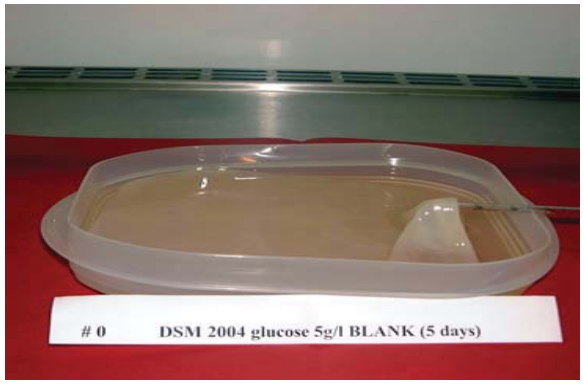


Cellulose nanocrystals (CNC)

Bacterial cellulose

Bacterial cellulose is a microbial polysaccharide at high purity level.
Recognized as GRAS food ingredient by FDA





- Already used in commercial products : Nata de coco
- Various shapes can obtained form different carbons sources
- BC dispersions have pseudoplastic viscosity
- BC is a biodegradable, dimensionally stable thickener (stable against temperature and salt addition)
- Low-calorie and cholesterol lowering effect

For review : Shi Z et al., Food Hydrocolloids 35, p 539 (2014) / Omoto and al., handbook of hydrocolloids p321, CRC Ed

Nanocelluloses as food additives

BC and NFC due to the three-dimensionnal structure display thickening, gelling and water binding properties

- Theses properties can be successfully used in various food products[1]:

  - Adding nata to meat paste has been proposed as a viable replacement for fat in Chinese-style meatballs[2]

  - NFC addition to hamburger reduce the weight loss after frying whitout any side effect on taste.[3]

  - NFC have a favourable effect on baked bread (softer texture and better appearance). Lower content of NFC compared to starch for similar effect. [3]

(1) Suspensions containing microfrillated cellulose US Patent 4,487,634 D11, 1984.

(2) Lin, K. W., & Lin, H. Y. Quality characteristics of Chinese-style meatballcontaining bacterial cellulose (Nata). Journal of Food Science, 69(3), Q107 Q111, 2004

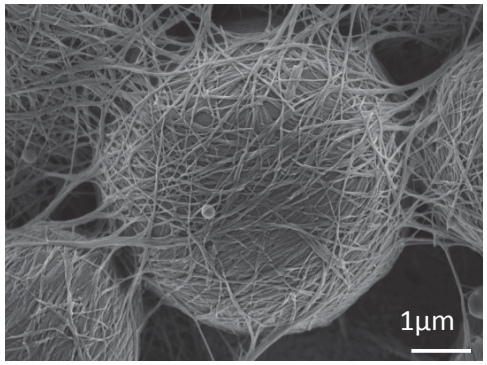
(3) Innventia report 403 : Nanocellulose as an additive in foodstuff, June 2013

Nanocelluloses in food application

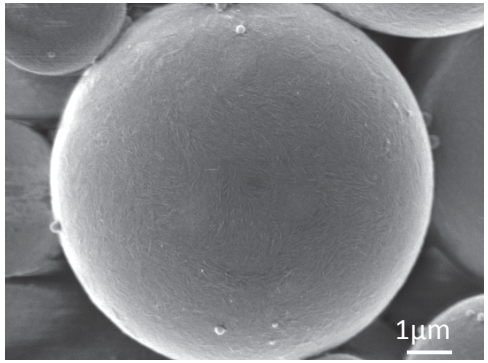
BC, NFC and CNC can stabilized emulsions

- Stable over long period, pH 2-10, T°, ..
- Low amount of NC are required due to irreversible adsorption

BC and NFC yield 3D network [1]



CNCbased Pickering emulsions [2]



(1)Suspensions containing microfrillated cellulose US Patent 4,487,634 D11, 1984. Lightweight and Strong Cellulose Materials Made from Aqueous Foams Stabilized by Nanofibrillated Cellulose, Wagberg et., Biomacromolecules, 14, 503-511, 2013

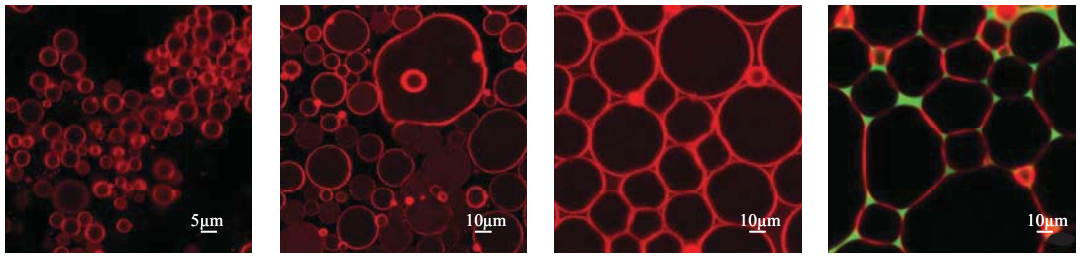
(2)New Pickering Emulsions Stabilized by Bacterial Cellulose Nanocrystals (BCN). Kalashnikova, I., et al Langmuir, 27, 7471–7479, 2011; Cathala, B. et al , Patent WO2012/017160, 2010.

Nanocelluloses new devlopment

-High internal phase emulsions : up 95% of oil with tunable texture

Increasing the oil content

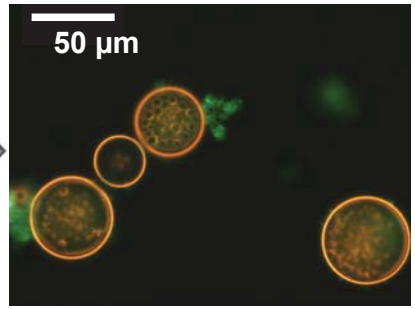
30 % 45 % 72 % 84 %



Neutral CNC

Charged CNC

-Double emulsions



(1)Surfactant-free high internal phase emulsions stabilized by cellulose nanocrystals, I.Capron and B. Cathala Biomacromolecules, 14 (2), pp 291–296, 2013; Capron, I., et al patent WO2013/001189

Reglementary status

In US Bacterial Cellulose has been recognized as GRAS since 1992

In EU, cellulose is accepted as food ingredient :

- microcristalline cellulose (E 460) ou cellulose derivatives (E 461-69)

What will be the status of Nanocellulose?

- BC is a microbial polysaccharide
- NFC/CNC : novel food or E 460?

Nano concerns in EU

-Declaration requirment in France since one year. Belgium, Italie, Denmark, UK and Germany are on the way. Nancellulose?

- Safety evaluation

Summary and perspectives

NC can be efficient food additives :

- Higher functionnalities with lower dose can be expected
- Mostly dimensionnaly stable (pH, ionic strenght, T°)
- Thickening, gelling, water binding properties and emulsions stabilizing agent
- Low-calorie and cholesterol lowering effect

- Devellop research targets
  - NC fabrication process to food applications
  - Technological and nutritional properties evaluation
  - New products

- Tacle the question of NC reglementary status in food applications

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Thanks for your attention