Arbeitsgemeinschaft Getreideforschung e. V.

in cooperation with

**Max Rubner-Institut**
**Institute of Safety and Quality of Cereal**

# 68th Starch Convention

# April 04th – 05th 2017
# in Detmold

**Program**

**Evening Program**

**Exhibition**

**Participants**

**Summaries**

## Tuesday, April 04th 2017

**$08^{00}$ – $08^{30}$ Registration**

**$08^{30}$** **Opening Remarks** by the President of the Association of Cereal Research, **Götz Kröner**, Ibbenbüren (Germany)

### 1. Market

$08^{45}$ 1.1. **Sara Girardello,** Oxford (United Kingdom)
The reform of the EU sugar market and its implications for the starch sector

$09^{15}$ 1.2. **Denbigh R. J. Lloyd,** Haywards Heath (United Kingdom) and **Michael A. Radeloff**, Berlin (Germany)
Meeting changing consumer demands in non-food products – the implications for the starch industry and its development

**$09^{45}$ Communication Break**

### 2. Raw Material

$10^{15}$ 2.1. **Tanja Bantleon,** Berlin (Germany)
Morphological Changes of Native Aramanth Grain after Hydrothermal Treatment

### 3. Starch

$10^{45}$ 3.1. **Chloé Chevigny**, Nantes (France)
Shape-memory effect in amorphous potato starch: The influence of local orders and parachrystallinity

$11^{15}$ 3.2. **Els de Hoog,** Ede (The Netherlands)
Tribological properties of rice starch in liquid and semi-solid food

$11^{45}$ 3.3. **Yong-Cheng Shi,** Manhattan (USA)
Changes of Starch during parboiling of rice kernels

**$12^{15}$ Lunch Break**

### 4. Modification

$14^{00}$ 4.1. **Sandra Einerhand,** Amsterdam (The Netherlands)
Potential anti-obesogenic and programming effects of non-digestible starches

$14^{30}$ 4.2. **Yong-Cheng Shi**, Manhattan (USA)
Structural changes of starch during dextrinization

**$15^{00}$ Communication Break**

$15^{30}$ 4.3. **Stylianos Raphaelides**, Thessaloniki (Greece)
Production of spray dried starch molecular inclusion complexes on an industrial scale

## 5. Application

$16^{00}$ 5.1. **Joël Wallecan**, Vilvoord (Belgium)
Powder properties and their determination

$16^{30}$ 5.2. **Jeroen J.G. van Soest,** Herrenveen (The Netherlands)
Recent developments amongst which a starch based environmentally friendly wrapper: Mars goes for a biobased bioplastic candy bar wrapper based on second-generation feedstocks

$17^{00}$ 5.3. **Jens Buller**, Potsdam (Germany)
New modified starch for wet end application

$17^{30}$ **Exhibitor's Forum** – short term presentations

1. **Dieter Abeln**, Behn & Bates Maschinenfabrik GmbH & Co. KG
   The next level to hygienic filling

2. **Josef Stanner**, Andritz Gouda B.V.
   R&D activities in the starch industry

3. **Nico Schoot**, **van**, AB Enzymes GmbH
   AB Enzyme's portfolio of enzyme products for grain processing

4. **Mesut Kemal**, CEMSAN DIS TIC A.S.
   Cemsan - Leader in process engineering, process equipment manufacturing, providing control systems and supervision of installation & commissioning

5. **Hannjo Boden**, Riedel Filtertechnik GmbH

# Lunch

## Lunch will be served in the exhibition hall:

**The menu:**

**Tuesday, April 04th 2017**

Linen bowl with bacon & smokers

Vegetable soup with tortellini

Canapés with herb cream cheese

Canapes with trout filet

Small pizzas

Mini baguette rolls

Dessert: Strawberry cream

**Wednesday, April 05th 2017**

Bean soup with sausages

Borschtsch (Ukrainian vegetable soup)

Vegetable sticks

Salmon Fresh Cheese Rolls

Chicken slices

Dessert: Mousse au Chocolat

**Beverages:**

Mineral water

Coca-Cola

Orange juice

Apple Spritzer

**Bon appétit**
**and interesting conversations!**

# Evening Program

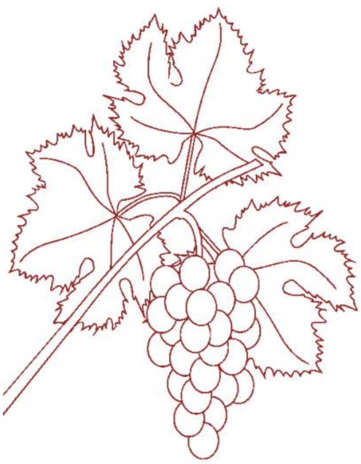
## Monday, April 03rd 2017

19:30 **Welcome Evening** at the **Exhibition Hall**, Detmold, Schuetzenberg 10

## Tuesday, April 04th 2017

17:30 **"Bread and Wine"- Get-together** in the "Haus des Brotes" (Exhibition hall), 32756 Detmold, Schuetzenberg 10

## Wine



**Ahr**
2014 "us de la meng" Red wine
Winery Meyer-Naekel, Dernau an der Ahr
Quality wine, dry

**Baden**
2015 Markgraeflerland Sauvignon Blanc
Winery Martin Wassmer, Bad Krozingen
Quality wine, dry

**Mosel**
2014 VINOVATION Premium Steillagen Riesling
Winery Paul Schunk, Bruttig-Fankel
Quality wine, dry

**Nahe**
2014 White Burgundy
Winery Joh. Bapt. Schaefer, Ruemmelsheim Castle Layen
Quality wine, dry

**Palatinate**
2013er "origin" red wine
Winery Markus Schneider, Ellerstadt
Quality wine, dry

**Rheinhessen**
2015 Qvinterra Scheurebe
Winery Carolin Spanier-Gillot & H.O. Spanier GbR, Bodenheim
Quality wine, dry

## Bread and pastries

Filled alkalis

Quiche Lorraine

Pizzas caps

Caraway rods & Cheese sticks

19:30 **Social gathering** at the restaurant "Strates Brauhaus", 32756 Detmold, Lange Str. 35

# Evening Program

## Wednesday, April 05th 2017

19:30 **Social gathering** at the restaurant “Waldhotel Baerenstein”, Am Baerenstein 44, 32805 Horn-Bad Meinberg, near the “Externsteine” in the Teutoburg Forest

## Buffet

**Starters**

Choices of green salad and raw food salads

Caprese tomato and mozzarella

**Main course**

Crispy braised leg of duck with cabbage in cream and potatoe gratin

Crusty roasts from pork, beans with bacon,with pepper sauce and small potatoes

Champignon-potatoes lasagne with chives

**Dessert**

Mousse au chocolat with fruit sauce

“Lippisches” wildberry stew with vanilla shank

## Bus transfer

A bus transfer is organized for you.

17:45 h **Bus stop 1** **AGF e.V. – Schuetzenberg 10**

18:00 h **Bus stop 2** **Sparda Bank - Willi-Brandt-Platz/Paulinenstrasse**
(For the Hotels Lippischer Hof, Detmolder Hof and Best Western Residenz, Altstadt Hotel)

18:15 h Meeting at Parking Place at **„Waldhotel Baerenstein“**, Am Baerenstein 44, 32805 Horn-Bad Meinberg

Guided Tour to the “Externsteine” in the Teutoburg Forest

19:30 h Dinner at Waldhotel Baerenstein

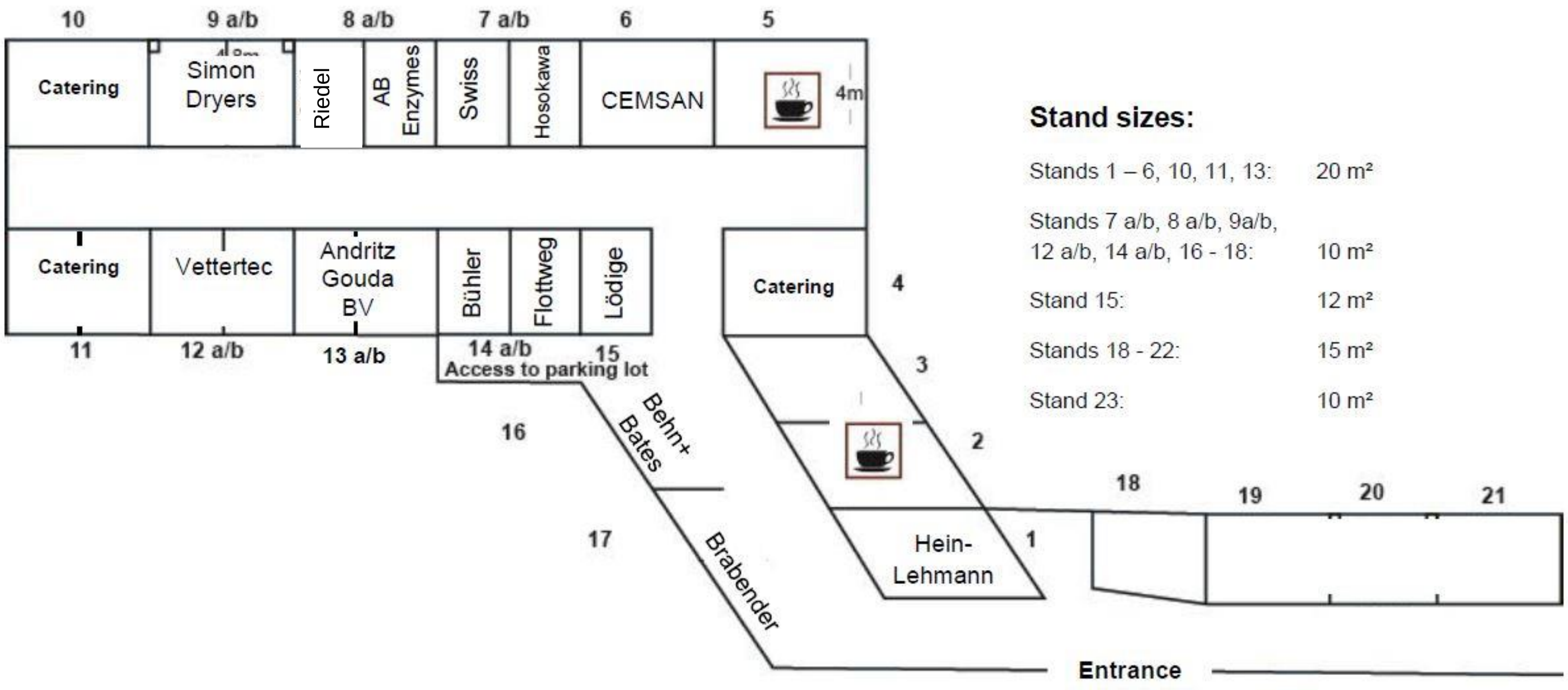
**Departure: from 21:30 h**

**Thank you!**

# Exhibition Hall Association of Cereal Research

## Stand allocation

**68th Starch Convention and 13th Bioethanol and Bioconversion Technology Meeting from April 4th – 6th 2017**




**Stand sizes:**

| | |
|---|---|
| Stands 1 – 6, 10, 11, 13: | 20 m² |
| Stands 7 a/b, 8 a/b, 9a/b, 12 a/b, 14 a/b, 16 - 18: | 10 m² |
| Stand 15: | 12 m² |
| Stands 18 - 22: | 15 m² |
| Stand 23: | 10 m² |

## Exhibition

**AB Enzymes GmbH,** Darmstadt (Germany)

**Andritz Gouda BV**, PD Waddinxveen (Netherland)

**Behn & Bates Maschinenfabrik GmbH & Co. KG,** Münster (Germany)

**Brabender GmbH & Co. KG,** Duisburg (Germany)

**Bühler GmbH,** Braunschweig (Germany)

**Cemsan DIS TIC A.S.,** Arifiye Sakarya (Turkey)

**Flottweg SE**, Vilsbiburg (Germany)

**Hein Lehmann GmbH,** Krefeld (Germany)

**Hosokawa Alpine AG**, Augsburg (Germany)

**Gebr. Lödige Maschinenbau GmbH,** Paderborn (Germany)

**Riedel Filtertechnik GmbH,** Leopoldshöhe (Germany)

**TUMMERS, Simon Dryers Technology,** Nottingham (United Kingdom)

**VetterTec GmbH,** Kassel (Germany)

**W. Kunz dryTec AG, SWISS COMBI,** Dintikon (Switzerland)

# Participants

Effective March 30th, 2017, 4 p.m.

| | |
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| Aubert, Michael | Novasep Process SAS, MIRIBEL Cedex (France) |
| Bahns, Christopher | Crespel & Deiters GmbH & Co.KG, Ibbenbüren |
| Bantleon, Tanja | Institut für Agrar- und Stadtökologische Projekte an der Humboldt Universität zu Berlin (IASP) |
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| Bergthaller, Wolfgang, Prof. Dr. | Lage |
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| Böcker, Georg, Dr. | Ernst Böcker GmbH & Co. KG, Minden, Vizepräsident der AGF |
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| Borgstedt, Michael | Friedrich-Wilhelm Borgstedt Milser Mühle GmbH, Bielefeld, Vizepräsident der AGF |
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| Dubinin, Alexander | CoonLab LLC, Minsk (Belarus) |
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| | |
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| Zaal, van der, Piet | Wageningen University & Research, Wageningen (The Netherlands) |

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Sciurba, Elisabeth, Dr.
Scheibner, Andreas
Schwake-Anduschus, Christine, Dr.
Stabenau, Gisbert
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Unbehend, Günter, Dipl.-Ing.
Vosmann, Klaus, Dr.
Weber, Lydia, Dipl.oec.troph.
Wiege, Berthold, Dr.
Wolf, Klaus

# Summaries

## 1. Market

1.1. **Sara Girardello,** Oxford (United Kingdom)
The reform of the EU sugar market and its implications for the starch sector

Quotas on EU sugar and isoglucose production will disappear in October 2017. The quotas dictated the volumes of sweetener that could be sold to the EU food and beverage sector. In response to this policy change, beet sugar producers and starch processors have been developing strategies for the new market environment.

The EU's sweetener market is supplied by beet sugar, isoglucose and imports. One thing about the future is clear: the potential supply of these sweeteners in the absence of quotas far exceeds domestic demand.

Indeed, the EU beet sector has made significant strides in the past and has now become very competitive both relative to other world sugar suppliers and to alternative crops within the EU. However, it remains to be seen whether sugar processors will be successful in securing enough beets to increase their sugar output. Longer term, the challenge for processors will be to manage the supply of beets as world sugar prices and alternative crop prices fluctuate over time.

In the isoglucose sector, there is a variety of processing costs in the EU, with the most competitive industries being located in the Central and Eastern regions. Here, however, endues markets are quite small. Indeed, the main sweetener markets are located in the North West of Europe; this is where availability of beet sugar is, and is expected to remain, the largest.

Looking ahead, the implications of the reform of the sweetener market may be different for the food and non-food sector.

• The price of sugar sold to food and beverage manufacturers is likely to experience a reduction/increase to become more closely aligned with world sugar prices, but most probably with a premium. This will influence isoglucose prices.

• Limits on EU sugar exports meant that sales to the non-food sector fell below world sugar prices (when production and world prices were both high). But, with no limit on exports in the future, these prices should fall no lower than world prices. This should lessen the competitive threat posed by sugar to hydrolysate price in years of high sugar output.

***Sara Girardello,*** *Head of Starch and High Intensity Sweetener Research. Sara heads the Starch and High Intensity Sweetener Team of LMC International Ltd. where she is responsible for LMC's consultancy services and our regular reports. These include our annual market database, the Global Markets for Starch Products, and our Global Sweetener Market and Outlook service. This second service examines demand by end-use for caloric and high intensity sweeteners, for all of the major markets. Sara also leads our annual Carbohydrate Processing service which presents a global cost database benchmarking raw material costs, co-product values and processing costs across a broad range of products and countries. She is the senior editor of LMC's monthly Starch & Fermentation Analysis. Sara holds an MA (Hons) in Economics from the University of Verona (Italy), an MSc in Applied Statistics from the University of Oxford (UK) and an MSc in Horticulture from the University of Reading (UK).*

1.2. **Denbigh R. J. Lloyd,** Haywards Heath (United Kingdom)
and **Michael A. Radeloff**, Berlin (Germany)

Changing consumer demands always significantly impact product design and manufacturing methods, and this is increasingly true in the case of non-food products. This lecture looks at some of the challenges and opportunities for the supply of agricultural-based products into this market sector. The interest in green chemistry has been revitalised into a new renaissance with the ever-growing consumer search for natural, sustainable lifestyles and products to match these expectations. When this is combined with a changing regulatory situation, raw material supply issues and considerably greater concern for the environment, a new picture emerges. This trend follows the path of food ingredient development, with the deliberate change to products manufactured with identified environmental care and utilising demonstrably natural components. For the starch industry, exploration of these areas of development present real opportunities.

***Denbigh Lloyd*** *is a Business Development, Marketing & Training Specialist based outside London. Looking at over 30 years extensive international food ingredients business experience including senior starch industry roles and active trade organisation representation at European and international level he is offering innovative marketing and business development consultancy from strategic focus and idea generation through to project management.*
*Providing sales, marketing and training services within the European food, drink and agroindustry he is running training workshops directly and on-line through Technology Training Courses, developing employee capabilities and competencies.*

***Dr Michael Radeloff*** *is a carbohydrate chemist from Hamburg University. He held several international management positions in the starch industry in R&D, Product Development and Marketing. Michael is the owner of Thales-Consult Berlin, a long established consultancy specialised in renewable agricultural raw materials, their derivatives and applications. The consultancy services are addressing client product development strategies, are analysing market opportunities, provide technical product application assessments and develop in-house customer training programmes.*

## 2. Raw Material

2.1. **Tanja Bantleon,** Berlin (Germany)
Morphological Changes of Native Aramanth Grain after Hydrothermal Treatment

In recent years consumption of alternative crops to supplement or replace common cereal grains like wheat, rice and maize has attracted much interest in the food industry. This is due to increasing and changing interest in human dietary habits. Especially the gluten-free pseudocereals are suitable for this. Amaranth is a rediscovered ancient crop and belongs to the pseudocereals (Belton & Taylor, 2002).

Boiling is one of the oldest processes to prepare food. Nowadays, wet cooking and pressure cooking is still a common process for daily preparation of porridge-like amaranth (Haros & Schoenlechner, 2017). Soaking is another hydrothermal processing method mostly used for legumes but soaking can also be a gentle and alternative preparation for amaranth grain.

In this study, the effects of soaking native amaranth grain were evaluated. *Amarathus caudatus,* ssp*. Oscar blanco* was used as mature grain. The soaking time and temperature are the main components for changing nutritious, physicochemical and textural properties (Leethanapanich, et al., 2016; Pan & Tangratanavalee, 2003). For this purpose, amaranth grain was soaked in an excess of water and exposed to different temperatures (20 °C, 50 °C, 60 °C, 70 °C, 80 °C) for different time periods (1 h, 5 h, 24 h) at atmospheric pressure. The selected soaking periods are based on the soaking processes of soybeans. Before processing soybeans must be soaked to change chemical and textural properties (Erickson, 1995). Temperature settings in this study are mostly chosen around the gelatinization temperature which starts around 68 °C (Calzetta Resio, et al., 2000).

Textural changes of the grain, water absorption, colour determination and Scanning Electron Microscopy were analyzed. In this context, the focus was on the textural changes (back extrusion test, loads up to 2,5 kN) of the soaked amaranth grain.

The gelatinization of starch influenced textural and water binding properties of amaranth. Textural, colour and water binding changes are the highest after reaching the gelatinization temperature (> 70 °C, ≥ 1 h) compared to native grain. Within experimental trials of 70 °C and 80 °C, the textural, colour and water absorption changes are not strong increasing (ranges: $R_{\Delta F,70°C}$= 75,20 N $R_{\Delta F,80°C}$= 13,69 N). At temperatures upon gelatinization temperature ( 70 °C and 80 °C) a maximum of texture softening ($F_{max,70°C,24h}$= 3,96 N, $F_{max,80°C,5h}$= 5,85 N, $F_{max,80°C,24h}$= 2,86 N) is reached.

Below gelatinization conditions, a stronger increase of softening processes of amaranth grain was observed (ranges: $R_{\Delta F,20°C}$= 53,07 N; $R_{\Delta F,50°C}$= 139,34 N, $R_{\Delta F,60°C}$= 96,89 N). In particular, longer holding periods (≥ 1 h) and higher temperatures (up to 60 °C) led to an increase in softening processes of the seeds.

Nevertheless, temperature was a more decisive factor than time. With higher temperatures, a softer texture could be achieved ($F_{max,20°C,1h}$=208,43 N > $F_{max,60°C,1h}$= 135,86 N). The most changes within the specific test series could be established at 50 °C ($F_{max,50°C,1h}$= 208,28 N, $F_{max,50°C,5h}$= 160,60 N, $F_{max,50°C,24h}$= 68,94 N). It can be determined, that the suspension of amaranth grains and water are fermented after 24 h. This is due to a spontaneous fermentation of amaranth grain (Sterr, et al., 2009), mostly occurred to lactic acid bacteria, identified by pH measurement ($pH_{50°C,24h}$ = 5,14) and microbiological test ($cfu_{50°C,24h,\ lactic\ acid\ bacteria}$= 5,3 x $10^5$) this relates to the study of Sterr, et al. (2009).

Textural changes of amaranth grain during soaking are important information for food processing. Depending on the objective of processing chain of amaranth grain, a soaking step is an alternative method for preparing food. Amaranth grain soaked under gelatinization temperature can be used for wet milling processes, and amaranth grain soaked slightly over the gelatinization temperature, can be an alternative gentle preparing process compared to cooking.

*__Tanja Bantleon__, 2008 – 2014: food technology studies at the TU Berlin, graduation: Dipl. Ing., Since 2014: PhD student at the department of food processing technology, TU Berlin, head of the department and PhD supervisor: Mr. Prof. Flöter; professional support: Mrs. Prof. Reimold, Hochschule Bremerhaven, Since 2014: scientific researcher at the IASP, associated with the HU Berlin*

## 3. Starch

3.1. **Chloé Chevigny**, Nantes (France)
Shape-memory effect in amorphous potato starch: The influence of local orders and parachrystallinity

In the current context of dwindling fossil resources, the development of renewable, bio-sourced, and biodegradable materials is of uttermost importance. The use of starch as a thermoplastic material has been developing recently, as it is a cheap and abundant resource, widely available in a lot of different plants and cereals.

Our team (MC2 team @ INRA-BIA laboratory in Nantes, France) works with the specificities of starch and aim at using them in new material applications, rather than modifying it wildly to approach the properties of "classic", synthetic polymers. For example, depending on the process, the composition of starch (proportion of amylose and amylopectin) or additives, extruded thermoplastic starch can present a very high shape-memory ability [1,2]. Thanks to the ability of water to plasticize starch, the shape-memory can be triggered by an increase in temperature or in humidity.

This opens the way to a wide range of applications combining the biodegradability and high water sensitivity of starch with its shape-memory, for example in the medical field. Resorbable medical implants have been developed such as spring-shaped stents for sialendoscopy surgery [3] or simpler biodegradable implants [4].

In order to better control such applications, a more insightful understanding of the structure-properties relationship in shape-memory starch materials is needed. In general, suitable shape-memory polymers structures are described as switching domains (amorphous) and netpoints (rigid), the latter determining the permanent shape of the material. In the case of amorphous starch, while the shape-memory property is clearly demonstrated, the local structure that would explain it is still unclear. Switching domains are assumed to be amorphous chains of amylose/amylopectin, with $T_g$ being the transition temperature. The netpoints could be entanglements, remains of crystalline structures like double or simple helices, hydrogen bonds, or paracrystalline structures.

To investigate this question, different amorphous starches were prepared, with different degrees of local organization (paracrystallinity): standard extruded potato starch and two other samples where we attempted to decrease the amount of local orders (annealed extruded potato starch and solvent-casted potato starch film). First the macroscopic properties were studied: glass transition temperature, Young's modulus, and shape-recovery (SR). While the extruded potato starch presented a usual close to 100% SR ability, the other two samples, prepared with more drastic conditions, had their SR ability decreased to below 50%. They also had lower glass-transition temperatures and rigidities.

After having successfully altered the shape-memory properties, it was necessary to link structure and properties, and so find a suitable technique which would be sensitive to local changes. X-Rays diffraction patterns did not show any exploitable differences, however this technique is sensitive to long-range orders mainly. CP-MAS NMR proved to be better-suited for our characterization. Indeed, the two altered samples presented less double helices/paracrystalline bundles and twisted conformations than the reference extruded potato starch. From this result we have been able to link paracrystallinity in macroscopically amorphous starch to enhanced shape-memory effect. We believe that local rigid orders such as double helices embryos or standalone double helices can be assimilated to the rigid netpoints creating enhanced shape-memory in amorphous starch materials [5].

The quantity of these specific conformations depends on the thoroughness of the amorphization process and whether it leaves enough time to reach energetically favored conformations. This opens the path to a simple and elegant control of shape-memory properties via process (extrusion parameters, annealing, solubilization time, etc.). In addition, other parameters influencing the local orders in amorphous starch, such as amylose/amylopectin ratio, chain length, or branching rate, could be studied, both from a fundamental point of view and an applied one, to tailor macroscopic properties.

***Chloé Chevigny*** *specializes in structure-properties relationships in polymeric materials, and is currently working on innovative starch-based biomaterials. She obtained her PhD in Polymer Physics in 2009 from the University Paris-XI after working on polymer-grafted nanoparticles for composites, then worked for two years at the Stranski-Laboratorium at the TU Berlin for a project on polyelectrolytes multilayers. She joined the INRA research institute of Nantes as a tenured scientist in 2012.*

3.2. **Els de Hoog,** Ede (The Netherlands)
Tribological properties of rice starch in liquid and semi-solid food

Lubrication plays an important role in the perception of foods, and can be measured with tribology. In this study we compare the lubricating behaviour of different particles in two types of matrices: liquid and semi-solid model food systems. Food particles were selected from the three groups of macronutrients: fat droplets with different solid fat content, microparticulated whey protein (MWP) and rice starch. Both lubricating and rheological properties were determined and related to sensory perception.

Different particles affect the lubrication and sensory properties via different mechanisms due to their morphology. Fat droplets embedded in semi-solid gels reduced friction due to formation of fat films following a **plate-out** mechanism. Spherical MWP particles effectively reduced friction in both liquid and semi-solid matrices due to a **ball-bearing** lubrication mechanism. Irregular-shaped native and gelatinized rice starch particles increased friction due to **3-body abrasion**. Therefore, the fat-mimicking functionality of rice starch might be mainly due to increasing bulk viscosity.

The lubrication of rice starch particles was compared to that of quinoa starch particles. Both particles have a polygonal shape, but the rice starch particles are 5 – 10 times larger in size. This resulted in different tribological values.

During the presentation the various mechanisms will be supported by data and illustrated by schematic drawing.

***Els de Hoog*** *is a senior project manager flavour & texture at NIZO food research. She manages contract research projects for global food companies on texture related subjects leading multidisciplinary teams. Main focus areas of her expertise are mouth feel, perception, product stability, and encapsulation. She studied chemistry on the Utrecht University and obtained a PhD in Colloid and Physical Chemistry in 2001. After her PhD she started working at NIZO food research holding various functions.*

3.3. **Yong-Cheng Shi,** Manhattan (USA)
Changes of Starch during parboiling of rice

Parboiling is a three-steep hydrothermal process involving soaking, heating, and drying of rice. Parboiling can effectively change physical (e.g. resistance to breakage) and textural characteristics as well as improve nutritional values.

Parboiling conditions affect the physicochemical properties of rice such as color formation and cooked rice texture because of differences in polymorphic forms of starch: residual starch, reassociated starch, and amylose-lipid complexes. In this study, isolated rice starch, milled rice, and paddy rice kernels of the same variety (18% amylose) were examined after steeping at temperatures (60 -75 $^{o}$C) below and above the onset of rice starch gelatinization temperature for different durations in a 2:1(w/w) ratio of water to kernel.

Rice starch granules and kernel characteristics were significantly altered during steeping and changes in isolated starch differed from those inside the rice kernels. The morphologies of starch granules within rice kernels were examined immediately after the steaming process (110 $^{o}$C for 20 min) and after aging of the parboiled rice. Freshly, one-month aged, and commercial parboiled rice were studied to better understand the parboiling process. Starch was completely gelatinized as determined by differential scanning calorimetry, and X-ray diffraction, indicating the disruption of all short-range crystallinity of starch in parboiled rice.

However, scanning electron microscope images showed intact starch granules, and light microscopic images showed starch granules embedded in the center of the rice kernel. Interestingly, these granules displayed Maltese cross patterns and birefringence but were not crystalline. For the first time, we demonstrated that parboiled rice starch granules could swell in glycerol to four to five times of its original size but still showed Maltese cross.

***Dr. Yong-Cheng Shi*** *is a professor in the Department of Grain Science and Industry at Kansas State University (KSU). He received his Ph.D. in Grain Science with an emphasis in starch chemistry from KSU. Prior to becoming a faculty at KSU in 2006, he worked for National Starch Food Innovation (Bridgewater, New Jersey) from 1994 to 2005. His research areas include structure and function of cereal carbohydrates, physical, chemical, and enzymatic modifications of starches and flours, and developing technologies and products for food, nutrition, emulsion, encapsulation, and pharmaceutical applications. He has 15 granted US patents, numerous corresponding patents throughout the world, and more than 60 publications pertaining to starch and cereal carbohydrates. He co-edited a book with Dr. C. C. Maningat on Resistant Starch: Sources, Application and Health Benefits in 2013. He was an Associate Editor of Cereal Chemistry from 2006 to 2013 and currently sits on the Advisory Board of Starch and Food Digestion journals.*

## 4. Modification

4.1. **Sandra Einerhand,** Amsterdam (The Netherlands)
Potential anti-obesogenic and programming effects of non-digestible starches

For the first time in history the obese people outnumber the underweight in the world. In Europe, half of the population and 1 in 3 children are overweight or obese. Eating habits play important role in obesity. In many countries across the world fiber intake is too low. Evidence in adults shows there are health benefits associated with higher intakes of dietary fiber (e.g. reduced risk of heart disease, type 2 diabetes and weight maintenance). Of the non-digestible starches, resistant starch has been extensively studied in this respect.

However, soluble fiber dextrins, also called resistant dextrins, have been less well studied, but form an interesting class of fibers as they are soluble and therefore easier to apply in different food applications like beverages, dairy and bakery products. Compared to other soluble and insoluble fibers, soluble fiber dextrin was able to reduce energy intake and lower body weight in adults. Nevertheless, it might be more effective to intervene earlier, because it has been shown that what you eat in the first 1000 days of life, from conception until 2 years of age, has lifelong consequences. For instance, the macronutrient intake, especially sugar intake, during pregnancy is associated with infant BMI at 2 years of age. Resistant dextrins can be helpful to reduce sugar in food products by providing mouthfeel and fiber benefits.

To date, no studies have been published using resistant dextrins during the first 1000 days of life, but it would be intriguing to test if these resistant dextrins might be helpful in sugar reduction, increasing fiber intake, affecting weight gain and body fat mass early in life (e.g.

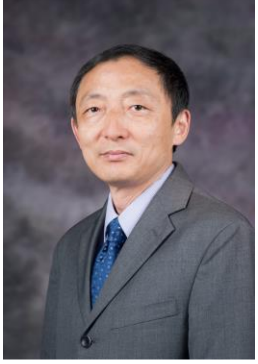
during pregnancy or in toddlers) thereby decreasing the risk of obesity and ensuring lifelong health.

***Dr. Sandra Einerhand** is the founder of Einerhand Science & Innovation BV, a consultancy providing nutritional solutions to infant formula and other food (ingredient) companies. Since the beginning of this year, she is also a partner of Nutrition Consultant Cooperative. Before she worked for Danone Nutricia Research (NL) 2011-2015, Tate & Lyle Ingredients (F), 2007-2011 and Lipid Nutrition (NL) 2004-2007 as Scientific Program Director and Nutrition & Health Director leading large scientific programs to bring new prebiotics, probiotics, lipids and infant formula products (among others) to the market with scientifically proven health benefits yielding several patents. During the first part of her career (1992-2004) she worked as associate professor specialized in prevention and treatment of gastrointestinal diseases in children and published over 100 articles in peer-reviewed journals and secured fundraising from national and international organizations. She studied Chemistry in Amsterdam and has a PhD in Life Sciences. She has more than 20 years of experience in business-oriented research management and innovation in early life nutrition (including prebiotics, probiotics and lipids), gut and metabolic health sciences. Some of her current activities focus on sugar reduction/natural sweeteners and on developing new natural ingredients/products to help maintain metabolic health.*

4.2. **Yong-Cheng Shi**, Manhattan (USA)
Structural changes of starch during dextrinization

Structural changes during the conversion of insoluble waxy maize starch granules to cold water–soluble pyrodextrin were investigated. Starch granules were suspended in water and the pH of the slurry was adjusted to 2.5–3.0 by 0.5M HCl. The air-dried starch was heated for different time intervals at 160 and 170 °C for 0.5 to 4 h. The pyrodextrins obtained had cold water solubility from 21 to 100%. Structural changes of starch granules during dextrinization were determined by multiple techniques.

In a mixture of water/glycerol (20/80, w/w), the small-angle X-ray scattering characteristic peak at 0.6 $nm^{-1}$ decreased in intensity as pyrodextrin solubility increased. The peak disappeared as pyrodextrin solubility reached 100%. Starch molecular size, crystal size as well as its melting enthalpy decreased as pyrodextrin solubility increased. Pyrodextrins had a granular shape identical to the native starch when observed in glycerol under a light microscope and showed strong birefringence under polarized light. It is proposed that starch molecules were hydrolyzed into small molecular fractions but remained in a radial arrangement. $^{1}H$ and $^{13}C$-NMR spectra of pyrodextrin were assigned with the assistance of 2D techniques. New glycosyl linkages were formed and transglucosidation occurred during dextrinization. The resulted pyrodextrin was highly branched and more resistant to enzyme digestion.



***Dr. Yong-Cheng Shi** is a professor in the Department of Grain Science and Industry at Kansas State University (KSU). He received his Ph.D. in Grain Science with an emphasis in starch chemistry from KSU. Prior to becoming a faculty at KSU in 2006, he worked for National Starch Food Innovation (Bridgewater, New Jersey) from 1994 to 2005. His research areas include structure and function of cereal carbohydrates, physical, chemical, and enzymatic modifications of starches and flours, and developing technologies and products for food, nutrition, emulsion, encapsulation, and pharmaceutical applications. He has 15 granted US patents, numerous corresponding patents throughout the world, and more than 60 publications pertaining to starch and cereal carbohydrates. He co-edited a book with Dr. C. C. Maningat on Resistant Starch: Sources, Application and Health Benefits in 2013. He was an Associate Editor of Cereal Chemistry from 2006 to 2013 and currently sits on the Advisory Board of Starch and Food Digestion journals.*

4.3. **Stylianos Raphaelides**, Thessaloniki (Greece)
Production of spray dried starch molecular inclusion complexes on an industrial scale

Custom produced pregelatinised normal maize starch was employed as a raw material for the production of spray dried starch complexed with fatty acids as a test material to assess the effectiveness of the method to be used for future industrial applications; especially for the production of molecular inclusion complexes for nutritional and therapeutic purposes. The starch was pregelatinised by drying a 10% aqueous dispersion of native starch by means of a double drum drier.

The formed dried sheet of gelatinized starch was comminuted by means of a high speed rotating cutter and the powder formed was dispersed in water at 70$^{o}$C, under continuous stirring. Then, aqueous solution of potassium salt of myristic or palmitic acid was added to the starch suspension, and the mixture was kept at this temperature under constant stirring for few minutes to ensure complete complex formation between the available amylose and the fatty acid. The feed solution was then sent by means of a mono pump to the operating spray drier and samples of the powder produced were collected from the bottom of the cyclone collector. Process optimization was carried out by means of a series of experimental runs where different values of process variables were employed.

To investigate the modifications which might be induced to the dried product due to the spray drying process, samples of starch suspension were taken from the feed tank prior to spray drying and were air dried at ambient temperature at every batch run, to be used for comparison with samples taken from the final spray dried products. Structural and morphological characteristics of samples were assessed using techniques such X-ray diffractometry (XRD), scanning electron microscopy (SEM), differential scanning calorimetry and confocal laser scanning microscopy (CLSM).

Functional properties such as particle size distribution, apparent density, bioavailability and oxidative stability were also determined. Particle size analysis showed that the volume mean diameter of the spray dried samples ranged from 19.22 to 44.38 µm. It was revealed that the lower the feed rate of the starch suspension the larger the size of the particles was. Bulk density of the spray dried samples ranged from 0.25 to 0.5 g/mL indicating a porous structure characteristic of the spray dried products which ensures good functional properties such as wettability and dispersibility. XRD spectra confirmed the formation of the amylose-fatty acid complexes showing the characteristic peak of V-structure at 19.7$^{o}$ (2-theta) whereas the degree of crystallinity ranged from 12 to 13%. On the other hand the percentage crystallinity of the samples obtained from the feed tank and air dried at ambient was on average 30%. The difference was attributed to the high temperature gradient prevailed inside the drying chamber in comparison to that of the ambient air dried samples which was insignificant. Moreover, the crystal size of the spray dried samples ranged from 16 to 40 Å whereas that of the ambient air dried ones averaged 55 Å. Thermal analysis revealed that the enthalpy of dissociation of spray dried complexes ranged from 1.7 to 2.5 (J/g) whereas that of the ambient air dried complexes ranged from 7.8 to 11.8 (J/g) indicating that the dissociation enthalpy of the complexes is percentage crystallinity dependent. SEM photos of spray dried particles revealed that they had a rather spherical shape studded with cavities resembling craters whereas samples dried at ambient revealed a continuous, rather compact, matrix whose surface was dotted with protrusions with a spherical shape resembling that of spherulites. CLSM photos showed that fatty acids were uniformly fused throughout the mass of the spray dried particles. Similarly, a homogenous distribution of the fatty acid molecules throughout the matrix of the ambient air dried starch systems was observed.

Summarizing, the final product was composed of particles of microscale dimensions with low bulk density, low crystallinity and small size crystals thus providing the desired functional characteristics required for the production of nutraceuticals, based on their use as a raw material.

***Stylianos N. Raphaelides**: Professor of Food Processing at the Department of Food Technology; Dean of the Faculty of Agricultural Technology, Food Technology and Human Nutrition, ATEI of Thessaloniki, Greece. Director of Studies of an MSc two year course titled "Quality Management and Production Organization Systems for the Food Industry". He holds a BSc in Chemistry (Aristotle University of Thessaloniki), a MSc in Food Process Engineering (The University of Reading, UK) and a PhD in Food Science (Strathclyde University, UK). Visiting Professor at the Institut Superieur d' Agriculture, Université Catholique de Lille, France (1993). Visiting researcher at the Institute of Chemistry of the Chinese Academy of Science, Beijing, China (1995). Six years industrial experience in food processing in UK and Greece. Consultant to the Food Industry on process design. Over thirty years research experience in the physical chemistry of starch and other polysaccharides, extrusion cooking and food rheology. Co-inventor of the European Patent No 1445599/2009, 'U-tube rheometer for the dynamic measurement of elasticity'.*

## 5. Application

5.1. **Joël Wallecan**, Vilvoord (Belgium)
Powder properties and their determination

Fine powdered ingredients are widely used in many industrial applications. To illustrate, about 60% of all products produced in the chemical industries in Europe are bulk solids (Schulze, 2008). Drying, conveying, storage, dosing and several other ways of fine powder handling are every day's business in the chemical, food, feed and pharmaceutical industries. Problems like blockage of equipment, difficult charging/discharging of silos, segregation or inaccurate volume dosage occur on a regular basis and complicate maintenance of operation as well as compliance with quality requirements.

Often these problems are caused by dusting, caking and poor powder flow. Especially fine powders are highly cohesive and can be a challenge for process engineers.

Bulk solids are many-particle systems, which consist of a disperse solid inner phase and a gaseous outer phase, whereas the solid phase single particles are interacting. For characterizing their properties not only the single particles have to be considered but also the bulk product behavior as well as characteristics of the specific material (Weber, 2009). In the case of starch and its derivatives, moisture sorption and desorption properties have to be considered in order to relate the physical state of the product to its bulk behavior.

Parameters such as molecular weight distribution heavily impact the sorption properties of starches and maltodextrins as well as their glass transition evolution. These in turn affect the flow properties of the materials as well as their throughput in downstream processes such as packaging and storage. Next to that, processing history and starch cultivar can play a significant role on its bulk behavior, which puts additional constraints when designing highly flexible processes.

***Joël Wallecan** works since 2003 at the Cargill R&D Centre Europe BVBA in Vilvoorde/Belgium. He currently leads the Physical Chemistry team within the Ingredients, Material & Nutrition R&D, a research-oriented department within the Cargill R&D organization. His areas of interest are thermal analysis, powder characterization and plant cell walls. He holds a Chemical Engineering degree from the University of Brussels, an MBA from the Anton Jurgens Institute and a PhD from the Université Pierre et Marie Curie.*

5.2. **Jeroen J.G. van Soest,** Herrenveen (The Netherlands)
Recent developments amongst which a starch based environmentally friendly wrapper: Mars goes for a biobased bioplastic candy bar wrapper based on second-generation feedstocks

The paper describes a co-creation of a novel packaging film made from starch and biobased components by biaxial stretching. Rodenburg Biopolymers developed a tailor-made compound based on second generation starch derived from waste water of the potato processing industry. The compound is suitable for biaxial stretching and shows unique properties. The innovative packaging solution is a joint development by Mars, Rodenburg Biopolymers, and Taghleef Industries. This innovative packaging meets the ever-increasing trend for sustainable packaging solutions.

The paper will show the research and development process and how problems where overcome during the process. The unique properties of the product include an interesting flexibility, natural feel and look but also its unique low density. The reasons behind these unique properties were researched and will be discussed. Furthermore LCA data will be presented as well as data on biodegradability research.

Mars, Rodenburg, and Taghleef have been announced as the winner of the 2016 ‘Oskar’ in the bioplastics industry for its bio-based film made from potato waste starch.

***Dr. Jeroen van Soest*** *studied Chemistry at University of Utrecht and has a PhD in starch based plastics. He has over 80 publications and patents and over 100 presentations at international conferences. He is winner of several scientific development prizes (amongst which the Prix Cerealier). He is expert in the field of analytical chemistry and biopolymer, amongst which starch or carbohydrate, product developments (products like FlourBond, Paragon, Solanyl). He has experience in new product- and market development from ideation to commercialization. Specialties: working with customers, communication, innovation, product development, management. Technical background: Carbohydrates, Polysaccharides (Starch, Gums), Proteins, Biopolymers - Food, Feed and Non-Food products, Analytical chemistry, Quality Control. Currently he is BU manager of the Carbohydrates Competence Center CCC of Eurofins Food NL. He has been working for various renowned companies like Rodenburg Biopolymers, CPKelco, Meneba.*

5.3. **Jens Buller**, Potsdam (Germany)
New modified starch for wet end application

Wet-end starch is used in paper manufacturing as retention aid which supports sheet formation and influences desired paper properties. In paper mills it is continously jet-cooked and applied directly as aqueous solution to the fiber suspension. Cationic starch derivatives are among the most prominent auxilliaries in the wet-end of the paper machine. However for environmental reasons today paper mills are moving on to closed loops for production water, resulting in an enhanced accumulation of salts and impurities. Consequently this leads to substantial reduced retention of conventional wet-end starches and hence lower paper strength. This lower efficiency cannot be compensated by a higher degree of substitution.

In an effort to meet the requirements of paper manufacturing in heavily loaded process water and guarantee high retention on the fiber with increased paper strength, the further development of cationic starches was focused on structures with larger particulate dimensions. More over we intended to achieve a simplified processing of synthesized products prior to wet-end application at temperatures below 100°C helping paper mills to fulfill their targets in energy savings. To achieve these aims different starch derivatives were synthesized through a combination of cationisation and crosslinking. Handsheet formation was carried out in a model water with a conductivity of 6000 µS/cm. Products with total destructurization of the granular structure caused a substancial higher retention at 4% starch addition however no equivalent gain in paper strength.

Better results turned out with starch dispersions of swollen particles in dimensions of nanometer- and lower micrometer scale containing a molecular dissolved fraction. Such small particulate hydrogel structures were synthesized on basis of corn, wheat and potato starch. The ratio of molecular dissolved starch to particulate fraction as well as the particle size distribution could be adjusted according to the pretreatment during modification with different degrees of crosslinking and preswelling temperatures and the conditions of dispersion preparation. The soluble and particular fractions were investigated using a combination of different methods including chromatographic methods like size exclusion chromatography and hydrodynamic chromatography. Sheet formation experiments with different starch products revealed that those structures lead to both beneficial retention behavior and higher paper strength. This positive performance was backed up in scale-up experiments on a paper machine of technical scale. Further promising results concerning a further improvement of retention and paper strength were achieved with partially hydrophobized cationic wet-end starches.

***Dr. Jens Buller**, born 1982, is a chemist and received his PhD in polymer chemistry at university of potsdam. Since 2013 he is working as a scientist in starch modification / molecular properties at the Fraunhofer Institute for Applied Polymer Research. His main interests in research lie in modification of starch particularly for technical applications like paper, adhesives and plastics.*

## 6. Enzymes

6.1. **Lubbert Dijkhuizen**, Groningen (The Netherlands)
Biochemical characterization of novel family GH70 4,6-alpha-glucanotransferase enzymes converting starch/maltodextrins into homopolysaccharides

The glycoside hydrolase (GH) family 70 originally was established for glucansucrases (e.g. GtfA of *Lactobacillus reuteri* 121) that convert sucrose into α-glucan polymers. In recent years we have identified enzymes constituting a first GH70 subfamily (e.g. GtfB of *L. reuteri* 121) inactive with sucrose, but displaying disproportionating activity with starch. GH70 members initially were found in lactic acid bacteria (http://www.cazy.org/). Subsequently we characterized a second GH70 subfamily (GtfC enzymes) in Gram-positive non-lactic acid bacteria, e.g. *Exiguobacterium sibiricum* 255-15. GtfB and GtfC enzymes are biochemically related, catalyzing a 4,6-α-glucanotransferase reaction, cleaving (α1→4)-linkages and synthesizing consecutive α1→6 glucosidic linkages. GtfC enzymes have a non-permuted conserved domain organization, and are evolutionary intermediates between GH13 (mostly α-amylase and other starch modifying enzymes) and GH70 (glucansucrases/GtfB-like 4,6-α-glucanotransferases) family proteins.

The products of these GtfB and GtfC enzymes are soluble dietary food fibers. Recently we characterized a third GH70 subfamily (GtfD enzymes) e.g. in the Gram-negative bacterium *Azotobacter chroococccum* NCIMB 8003. GtfC and GtfD enzymes share the same domain architecture and display transglycosylase activity with starch. However, this GtfD enzyme is unable to synthesize consecutive (α1→6) glucosidic bonds, instead it forms a higher molecular mass and relatively highly branched α-glucan with alternating (α1→4) and (α1→6) glucosidic linkages from amylose. This polymer is highly similar to the reuteran synthesized by the *L. reuteri* 121 GtfA glucansucrase from sucrose, regarded as a health promoting food ingredient. Most recently we characterized a GtfB enzyme from *Lactobacillus fermentum* NCC 2970, displaying 4,3-α-glucanotransferase activity, converting amylose into an α-glucan with alternating (α1→3)/α1→4 glucosidic linkages, and with (α1 → 3,4) branching points.

This novel GH70 reaction specificity expands the range of α-glucans that can be synthesized from starch/maltodextrins, and allows the identification of key positions governing the linkage specificity within the active site of the GtfB-like GH70 subfamily of enzymes.

***Lubbert Dijkhuizen*** *(professor of Microbiology, University of Groningen) studies transglycosylating enzymes acting on starch (e.g. alpha-4,6-glucanotransferases) or sucrose (e.g. glucansucrases). He has published >350 peer-reviewed papers and supervised 65 PhD students. Dijkhuizen is scientific director of the Carbohydrate Competence Center (http://www.cccresearch.nl; >30 MEuro budget for fundamental and innovative research; 25 companies and 5 universities), and CSO of the SME CarbExplore*

6.2. **Nina Schrögel-Truxius**, Darmstadt (Germany)
Xylanases and Endoglucanases in Wheat Starch Gluten Separation

The separation of wheat flour into starch and gluten has been known for more than 250 years. Nowadays there are three processes predominantly used in industry and known as the dough, batter-dough and batter process. In the latter part of the 20$^{th}$ century, the introduction of enzyme preparations containing xylanases and endoglucanases has led to an improvement in the wheat starch gluten separation process. The addition of an enzyme preparation containing xylanase or endoglucanase activity degrades the non-starch polysaccharides, leading to a decrease in viscosity and resulting in an improved performance in the wheat starch separation process. To gain a better understanding of the mechanism of enzyme actions, a laboratory procedure was developed based on the industrial batter process.

Enzyme preparations containing xylanases and endoglucanases were applied in the laboratory using wheat flour batter as a substrate. The viscosity of the batter was followed over time and the corresponding separations were carried out. All the viscosity curves followed the same trend and showed that an increase of enzyme dosage results in a greater decrease of viscosity over time when adding Xylanase 1 and Xylanase 2, while the Endoglucanase showed a faster decrease of viscosity at the beginning of the process especially with the highest enzyme dosage of 200 g/t. In addition to that, delta viscosity curves are shown, where the viscosities after two minutes as well as after 15 minutes of enzyme treatment are compared. Xylanase 1 showed a more slowly decrease of viscosity at the beginning in comparison to Xylanase 2. This could be associated with the inhibition effect of Xylanase 1 belonging to enzyme family GH 11, which is known of their lower catalytic universalism than GH 10 xylanases. Later on, Xylanase 1 shows a greater decrease in viscosity than Xylanase 2. This could be related to the speed of breakdown of WUAX (water un-extractable arabinoxylans), which is typical for GH 11 xylanases.

In general, Arabinoxylans have a high- water holding capacity. This aspect of releasing water from AX, which leads to an increased amount of supernatant and a reduced sludge phase, can be described by the breakdown of AX with the help of an enzyme. The results of the separation showed from bottom to top the fractions of starch-, gluten-, sludge- and supernatant phase. The supernatant phase is also known as the water and the soluble AX containing phase. The blank sample showed the highest amount of sludge phase and accordingly the lowest amount of supernatant. Adding an enzyme into the wheat batter, the separation results in a low sludge phase and accordingly a high amount of supernatant.

For a deeper scientific understanding of the observed effects an analytical method was developed, which allows the quantification of soluble and insoluble arabinoxylans formed during enzyme treatment. The blank sample had the lowest concentration of soluble AX in reference to insoluble AX. The results demonstrate that having no enzyme in the wheat flour batter no or only less solubilisation of AX will happen and thus results in a high batter viscosity and a poor separation afterwards.

All in all the developed model showed a good correlation between viscosity of the wheat batter, the separation of the individual fractions of starch-, gluten-, sludge-, and supernatant phases and the concentration of soluble as well as insoluble arabinoxylans.

***Nina Schrögel-Truxius*** *works for AB Enzymes for more than four years. In her role as Technical Service Manager for Food Enzymes she focuses on the development and application of enzyme products for the grain processing industry. She holds a Bachelor degree in Chemical engineering from Provadis University of Applied Sciences in Frankfurt, Germany.*

6.3. **Pieter van der Zaal**, Wageningen (The Netherlands)
The effect of starch linearity on GTFB-ΔN transferase activity during the synthesis of Isomalto/Malto-Polysaccharides

Starch is used in a wide range of applications due to its inherent functionality. The functionality of starch depends on its natural properties and these natural properties vary per starch source. In order to broaden the spectrum of starch functionality, it is often modified. This can be done *in planta*, chemically, physically and enzymatically. Recent trends in sustainable processing have sparked more interest in the enzymatic modification of starch.

Traditionally, starch bio-catalysis is focused on breaking down specific linkages with glucanohydrolase enzymes. However, more recently, starch is also modified with glucanotransferases. Instead of solely breaking down, glucanotransferase enzymes are capable of modifying starch by adding, deleting and shuffling the linkages in starch and other α-glucans. 4,6-α-glucanotransferase (GTFB-ΔN) is a glucanotransferase, capable of converting α-(1→4) linked glucans into α-(1→6) linked glucans, resulting in Isomalto/Malto-Polysaccharides (IMMPs).

IMMPs formed by 4,6-α-glucanotransferase are not necessarily 'new' products, but the ability to produce α-(1→6) glucans from starch opens up applications that were previously not realistic or economically feasible to pursue. Possible applications in food could be as a slowly-fermentable fibre with prebiotic potential.

We investigated the influence of starch's natural properties on the GTFB-ΔN transferase mechanism. IMMPs were produced from a selection of starches and subsequently fractionated with SEC-RI on a preparative scale. Linkage content was analysed with $^{1}H$ NMR and methylation-analysis and size was determined with GPC-MALLS. Results show that GTFB-ΔN does not incorporate linear α-(1→6) linkages in branched starch amylopectin, but hydrolyses the amylopectin instead. Linear starch amylose proves to be the preferred substrate for GTFB-ΔN transferase activity.

***Pieter H. van der Zaal*** *born on the 23rd of April 1989, high school (Da Vinci college, Leiden, the Netherlands), studied at Wageningen University (the Netherlands). Obtained a Bachelor in Food Science and Technology with a thesis in Food Microbiology (2010) and a Master in Food Ingredient Functionality with a thesis in Food Chemistry (2013). Currently, PhD candidate at the Biobased Chemistry & Technology group at Wageningen University & Research (2013/2017).*

## 7. Technology

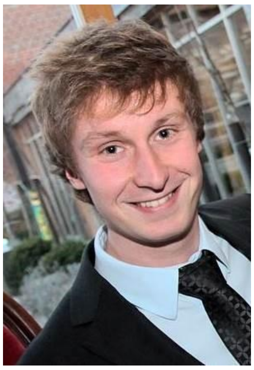
7.1. **Stijn Reyniers,** Heverlee (Belgium)
Impact of ball milling on the release of starch and the viscosity forming potential of potato flakes

Dehydrated potato derivatives are manufactured for producing potato-based convenience foods such as instant mashed potatoes and fried potato crisps. Such derivatives are produced by boiling potatoes after steam peeling, mashing and subsequent drying. The remaining products are then sold as drum-dried potato flakes or as air-dried potato granules. They contain cold water swelling starch which readily develops viscosity upon hydration. The potato flakes have a substantial amount of broken cells (40-60%) and extracellular starch. It is believed that these characteristics determine the functionality of potato flakes during processing. The objective of this study was to evaluate the impact of additional cell wall breakdown on the release of starch and the viscosity forming potential of potato flakes.

First, commercial potato flakes [80% starch on dry matter (dm), 8% protein dm, 3% ash dm and 7% dietary fiber of which 1.7% dm consists of uronic acids] were ball milled for 5, 15, 30 and 60 min. Both the particle size distribution and soluble uronic acid contents were monitored to assess the impact of ball milling on the breakdown of potato cell walls. Mean particle size of potato flakes decreased from 338 µm to 152 µm after 60 min of ball milling while the soluble uronic acid content increased from 1.1% dm to 1.4% dm. Also, a significant increase in extracellular starch content (from 14.7% dm to 19.0% dm) was measured.

Chain length distributions of the extracellular starch were determined with Size Exclusion High Performance Liquid Chromatography (SE-HPLC). The increase in extracellular starch was mainly attributed to a higher degree of extraction of amylopectin. Furthermore, the extractability of long amylose chains (degree of polymerisation 2,500-4,500) increased upon ball milling. The swelling and pasting properties of untreated and ball milled potato flakes were evaluated with the Rapid Visco Analyzer (RVA). Peak viscosity values of potato flakes at a dm content of 8% increased from 1,470 mPa.s to 2,260 mPa.s as a result of 60 min ball milling which went hand in hand with an increased swelling power (from 31.2 g/g to 35.3 g/g). Breakdown of potato cell wall material removes the physical barriers limiting the swelling and, hence, viscosity development of the flakes.

At the same time, the higher extracellular starch content led to 10% higher end viscosity values due to improved gel formation. In a next step, potato flakes were incubated with cellulase from *Trichoderma reesei* (0.10 EU/mg dm flake) for 1, 2, 4 and 6 h. A significant increase in extracellular starch content (from 20.4% dm to 30.5% dm) was measured after 6 h of incubation. Enzymatic cell wall breakdown mainly increased the extractability of amylopectin. Peak viscosity values of potato flakes at a dm content of 8% increased from 1,263 mPa.s to 2,078 mPa.s upon addition of 0.10 EU/mg cellulase to the flake suspension. We conclude that additional cell wall breakdown improves the swelling properties and gel forming capacity of potato flakes. Higher viscosity development upon hydration of potato flakes can enhance instant structure formation during processing.



***Stijn Reyniers*** *was born on July 29 1992 in Duffel, Belgium and currently lives in Mechelen, Belgium. In 2013, he obtained a Bachelor's degree at the faculty of Bioscience engineering at the KU Leuven. He finished his Master in Food Technology in 2015 at the same faculty, with his MSc Dissertation entitled: "Functionality of wheat flour gluten in pastry products". He currently works as a PhD student at the Laboratory of Food Chemistry and Biochemistry (KU Leuven), under the supervision of Prof. Jan A. Delcour. His research topic comprises the functionality and modification of pregelatinized starches from different botanical origins.*

7.2. **Berthold Wiege,** Detmold (Germany)
"Pickering emulsifiers" based on small granular starches - Manufacturing and physico-chemical characterization

Small granular starches from quinoa, amaranth, and rice were surface hydrophobized (esterified) with cis/trans 2-Octen-1-ylsuccinic anhydride (OSA) to different degrees of modifications (i.e. 0.6, 1.2, 1.8, 2.4, 3.0% of OSA) in aqueous alkaline slurry at pH = 8.2-8.4 at 32°C. The dry matter content of the suspensions was 17.7% and the reactions were carried out within 120-200 min.

The degree of substitution (DS) was determined by alkaline hydrolysis of the ester and titration back with sulfuric acid - as a reference method. Furthermore a quantitative FTIR-method was developed for determination of the amount of OSA which was chemically bound, by integration of the C=O bond of the ester (1728 $cm^{-1}$) and with a higher accuracy by evaluation of the –$COO^{(-)}$ -bond at 1569 $cm^{-1}$.

Physico-chemical properties of these "Pickering emulsifiers" were characterized by light scattering, scanning electron microscopy, and their pore size distribution (BET) . Emulsifying properties were determined in relation to the degree of modification and different starch/oil ratios (i.e. 50, 100, 200, 400, 800 mg starch/ml oil) by laser light scattering experiments.

It was feasible to formulate emulsions stabilized by small granular starches. Particularly, surface hydrophobized starches from quinoa and amaranth have a great potential for applications in the food, cosmetic and pharmaceutical industry. Unfortunately these starches are not commercially available. Currently, the high raw material price of quinoa and amaranth prevents applications of such emulsifiers in the food industry. In the case of cosmetic and pharmaceutical industry the situation seems to be different.

***Dr. Berthold Wiege,*** *born 1955 in Schoetmar (Germany), 1975-1981 Study of Chemistry, Diploma, University of Paderborn (Germany), 1981-1986 PHD in Physical Chemistry, University of Paderborn (Germany), 1989-today Max Rubner-Institute Detmold (Germany)*

7.3. **Maurice Essers,** Zeist (The Netherlands)
Future prospects of carbohydrate development at TNO and beyond

It is a tradition of TNO to give each year an oral presentation at the starch convention in Detmold. For more than 25 years, TNO gave insight in their efforts in the field of applied carbohydrate research. Various topics were addressed ranging from novel process development, biocatalysis, chemical characterization of polysaccharides, development of invitro digestibly assays, clean label modification, application (e.g. snacks) etc. Various TNO scientists have given their contribution such as Peter Steeneken, Albert Woortman, Ted Slaghek, Rob Havenaar, Peter Sanders, Harold Helmens, Rachel van der Kaaij, Kommer Brunt, Marc van der Maarel, Johan Timmermans, Lizette Oudhuis, Mans Minekus, Doede Binnema and Maurice Essers. This TNO tradition will come to an end as this part of TNO (Zeist) will merge into the Food and Biobased Research institute of the Wageningen University & Research next year. Applied research on carbohydrates in the Netherlands will be completely centralized in Wageningen, starting form 2018. From there on we will address our work with a different entity, not TNO but WUR.

The merge of this part of TNO and Food and Biobased Research of Wageningen (FBR) offers great opportunities, as the research activities in the field of carbohydrate research are very comprehensive and will re-enforce one another.

In this presentation it is foreseen to give an overview over the activities in the past and how these will evolve in our future research. Starch development will remain an important asset in our research, but focus on other polysaccharides will be of equal importance, for example the recovery arabinoxylans out of wheat bran and corn hull. Although this is currently intensively explored on academic level, it still remains underutilized. This will be one of our challenges in which we will give, in this presentation, an insight how and with what kind of technologies we are tackling this. Finally, it is our interest to share some research topics, regarding starch development, which will be presented in future at the convention. It remains our aim to contribute each year at the starch convention, although this will be done with a different identity.

***Maurice Essers,*** *after finishing high school (Joan of Arc lyceum in the Netherlands), I studied chemistry on the technical university in Aachen (RWTH). My professional career started at the South African Paper and Pulp industry (SAPPI) at R&D Maastricht. Then I joined Cargill and was assigned in Bergen op Zoom, Cedar Rapids (USA) and Krefeld (Germany). The main focus in my research was about that time modification of starches for industrial applications. Then I moved to Syral, formerlyTate and Lyle (R&D Aalst, Belgium), were I worked on the development of food and industrial starches. Since 2008, I'm employed by TNO and working in the carbohydrate group in Zeist. Since then the focus in my work is, clean label modification of starches, healthy carbohydrates, development green processes for making industrial starches, analytics and project management.*

# Memos

## Wednesday, April 05th 2017

### 6. Enzymes

$08^{30}$ 6.1. **Lubbert Dijkhuizen**, Groningen (The Netherlands)
Biochemical characterization of novel family GH70 4,6-alpha-glucanotransferase enzymes converting starch/maltodextrins into homopolysaccharides

$09^{00}$ 6.2. **Nina Schrögel-Truxius**, Darmstadt (Germany)
Xylanases and Endoglucanases in Wheat Starch Gluten Separation

**$09^{30}$ Coffee Break**

$10^{00}$ 6.3. **Pieter van der Zaal**, Wageningen (The Netherlands)
The effect of starch linearity on GTFB-ΔN transferase activity during the synthesis of Isomalto/Malto-Polysaccharides

### 7. Technology

$10^{30}$ 7.1. **Stijn Reyniers,** Heverlee (Belgium)
Impact of ball milling on the release of starch and the viscosity forming potential of potato flakes

$11^{00}$ 7.2. **Berthold Wiege,** Detmold (Germany)
Pickering emulsifiers" based on small granular starches - Manufacturing and physico-chemical characterization

$11^{30}$ 7.3. **Maurice Essers,** Zeist (The Netherlands)
Future prospects of carbohydrate development at TNO and beyond

$12^{00}$ **Closing remarks** by the Chairman of the Starch Experts Group, **Willi Witt,** Tecklenburg (Germany)