



Research seminar Tutkimusseminaari

Presentations of ongoing dissertation research projects
in the field of dairy science and technology
organized by the Finnish Dairy Science Society

Katsaus meneillään oleviin maitoteknologian alan väitöskirjatutkimuksiin
järjestäjänä Meijeritieteellinen Seura ry.

Time Aika	Wednesday, October 5, 2011 at 12.30 – 16.05 Keskiviikko, 5. päivä lokakuuta 2011 klo 12.30-16.05.
Place Paikka	University of Helsinki, Viikki campus, Building B / lecture hall 2. Street address: Latokartanonkaari 9, Helsinki. Helsingin yliopisto, Viikin kampus, B-talon luentosali 2. Katuosoite: Latokartanonkaari 9, Helsinki.

- *PROGRAM*
- *ABSTRACTS*

PROGRAM / OHJELMA

at / klo

- 12.30 *Opening words*, prof. Tapani Alatossava (MTS ry)
Each presentation 15 min + 5 min discussion.
- 12.40 Anna Denissova (Estonian Univ. of Life Sciences, Tartu):
Measuring lactose crystals size using dynamic light scattering.
- 13.00 Asmo Kemppinen (Helsingin yliopisto):
Maitorasvan triasyyliglyserolien analysointi kromatografisin ja massaspektrometrisin menetelmin.
- 13.20 Kevin Deegan (Univ. of Helsinki):
Novel processing modifications to improve the sensory and chemical properties of cheese.
- 13.40 Tiina Ritvanen (Evira, Helsinki):
Maukkaiden kevytjuustojen koostumus ja aistinvaraiset ominaisuudet.
- 14.00 *Coffee break* 40 min (building A / A-talon aula)
- 14.40 Tiina Kriščiunaite (Tallinn Univ. of Technology, Tallinn):
Milk coagulability.
- 15.00 Lourdes Mato Rodriguez (Univ. of Helsinki):
The role of copper in the manufacture of Finnish Emmental cheese.
- 15.20 Terhi Aaltonen (Valio Oy & Helsingin yliopisto):
Juuston valmistus täyskonsentroidusta maitotiivisteestä.
- 15.40 Dilek Ercili-Cura (VTT, Espoo):
Structure modification of acid milk gels through protein cross-linking.
- 16.00 *Closing words* (5 min), prof. Tapani Alatossava.

In addition / Lisäksi:

After the seminar an opportunity for a guided visit (about 45 min) to the dairy technology teaching and research laboratories in Viikki is offered. Coming together at the lobby of the building EE (street address: Agnes Sjöbergin katu 2) at 16.15 o'clock.

Seminaarin jälkeen on mahdollisuus opastetulla tutustumiskäynnillä (n. 45 min) tutustua maitoteknologian opetus- ja tutkimustiloihin Viikissä. Kokoontuminen EE-talon (katuosoite: Agnes Sjöbergin katu 2) ala-aulaan klo 16.15.

ABSTRACTS (8)

Measuring lactose crystals size using dynamic light scattering

Anna Denissova, Väinö Poikalainen & Avo Karus

Lactose crystallization has been subject of scientific investigation for a long time. Now with the development of nanotechnology it became possible to study this process at the molecular level. One possibility is the use of Dynamic Light Scattering (DLS) method. It measures nanoparticles Brownian motion in liquid and relates this to the size of particles.

In current study the possibility to estimate lactose molecule size distribution in water solution with the Zetasizer Nano ZS was investigated. Lactose solutions of 5% and 10% were prepared in ultra pure water and filtered. Measurements were carried out at the temperature of 20 °C.

Both concentrations gave a bimodal distribution with the main peak mode consistently around 1 nm diameter and a second peak mode in range from 100 to 1000 nm. Presumably, the second peak shows the particles, which can be initially interpreted as a secondary contamination of lactose solution. Inasmuch as main peak was in a predicted place, it was decided to leave the presence of the second peak out of account. The main peak mean was 1.0929 nm that corresponds to the size of lactose molecule.

The results, obtained from this work, show, that the lactose molecule size is possible to measure using dynamic light scattering. Future studies will be carried out to assess the beginning of lactose crystallization by means of DLS method.

Maitorasvan triasyyliglyserolien analysointi kromatografisin ja massaspektrometrisin menetelmin

Asmo Kemppinen & Paavo Kalo

Tutkimuksen tavoitteena oli kehittää menetelmiä maitorasvan (MR:n) ja muunnellun MR:n triasyyliglyserolien (TAG:ien) kromatografiseen ja massaspektrometriseen analysointiin. Erityistä huomiota kiinnitettiin lyhytketjuisia rasvahappoja sisältävien TAG:ien paikkaisomeerien (*sn*-1,3- ja *sn*-2-isomeerien) määrittämiseen. MR:n TAG-tutkimus vaatii yleensä useiden eri menetelmien yhdistämistä, koska MR:ssa on paljon rakenteeltaan erilaisia mutta kemiallisilta ominaisuuksiltaan lähes samanlaisia TAG-molekyylejä. Tässä tutkimuksessa kehitettiin argentaatiopylväskromatografiaan perustava, MR:lle räätälöity menetelmä, jolla TAG:t saatiin jaettua tyydyttyneisyydeltään erilaisiin puhtaisiin jakeisiin jatkotutkimuksia varten. Tutkimuksessa selvitettiin polarisoituvien fenyyli(65 %)metyylikolonniin kykyä erottaa lyhytketjuisten TAG:ien paikkaisomeereja toisistaan kaasukromatografisesti. Tutkimuksessa käytetyillä massaspektrometrillä menetelmillä (GC–EI–MS; np-HPLC–ESI–MS/MS) pystyttiin kvantitoimaan yleisimpiä MR:n TAG:ja, harvinaisia pienkomponentteja ja lyhytketjuisten TAG:ien *sn*-1,3/*sn*-2 paikkaisomeereja. Kvantitointi edellytti kokeellisesti määritettyjen, fragmentti-ioneille spesifisten moolivasteiden käyttöä. Lisäksi saatiin uutta tietoa lyhytketjuisten TAG:ien *sn*-1,3- ja *sn*-2-isomeerien fragmentoitumisesta EI–MS:ssa ja ESI–MS/MS:ssa. Kehitetyjä menetelmiä voidaan hyödyntää verraten tyydyttyneiden ravintorasvojen perustutkimuksessa, tuotekehityksessä ja valvonnassa arvioitaessa esimerkiksi niiden ravitsemuksellista ja teknologista laatua.

***Novel processing modifications to improve the sensory
and chemical properties of cheese***

Kevin C. Deegan, Noora Heikintalo, Jyri Rekonen,
Paul McSweeney, Tapani Alatossava & Hely Tuorila

Complex biochemical and microbiological changes occur throughout ripening which influence the flavour and texture of cheese. The aim of this study was to modify and improve the sensory characteristics of cheese through the use of a novel processing modification in cheesemaking. Lipoprotein lipase (LPL), an indigenous milk enzyme normally largely inactivated by pasteurisation, was exploited to modify milk fat, exposed by various homogenisation pressures (0, 50 and 100 bar). Following homogenisation, milks were held at 37°C for 1 h and pasteurised at 72°C for 15 s, Emmental cheese was made therefrom using a standard process in three replicate trials. A control cheese was made from unhomogenised milk.

Sensory profiling of cheese was performed at 90 d of ripening. Attributes (22) were evaluated by a panel of 15 assessors. Descriptive terminology and attribute reference standards were developed during training. Principal component analysis showed that cheeses made from homogenised milk were separated from non-homogenised cheeses on PC1 (51% of explained variance). Homogenised milk cheeses were rated higher for taste and odour intensity, were smoother and harder, while more acidic and salty. Temporal dominance of sensations (TDS) was defined for cheese samples using the same panel of assessors and indicated the most dominant attribute at any one time during mastication. Compared to the control cheese, homogenised milk cheeses were significantly saltier at the start of mastication and more acidic throughout. This was supported by the significantly higher salt contents found in the homogenised milk cheeses by compositional analysis. Homogenised milk cheeses differed from control cheeses by being more dominantly crumbly at the start of mastication and smoother before deglutition.

Improvements in aspects of Emmental sensory quality were achieved. Ongoing analyses will investigate the effect of LPL on volatile compounds in the cheese, which contribute to flavour, and on the possibility of use of the novel processing routine to improve the sensory characteristics of reduced-fat Emmental cheese.

Maukkaiden kevytjuustojen koostumus ja aistinvaraiset ominaisuudet

Tiina Ritvanen, Leena Lilleberg, Tuomo Tupasela,
Ulla Suhonen, Susanna Eerola, Tiina Putkonen & Kimmo Peltonen

Tutkimuksen tavoitteena oli selvittää kypsytettyjen vähärasvaisten juustojen (edam, emmental- ja kermajuustotyypiset) miellyttävyyteen vaikuttavia kemiallisia ja aistinvaraisia ominaisuuksia. Juustojen miellyttävyyttä arvioitiin kuluttajatuotetestillä, missä kuluttajat arvioivat näytteiden ulkonäön, suutuntuman, flavorin ja kokonaisuuden miellyttävyyttä 9-portaisella arviointiasteikolla. Asiantuntijaraati teki juustoille aistinvaraisen profiilianalyysin. Eri juustotyypeillä oli valittuja ulkonäköön, rakenteeseen ja flavoriin liittyviä ominaisuuksia, joiden voimakkuutta arvioitiin portaattomasti 10 cm pituisen janan avulla. Lisäksi määritettiin juustojen kuiva-aineen, rasvan, suolan ja vapaiden aminohappojen pitoisuudet. Koostumuksen ja aistinvaraisten ominaisuuksien vaikutusta miellyttävyyteen arvioitiin Spearmanin korrelaatiomatriisin ja Preference Mapping -tekniikan avulla.

Mielenkiintoinen huomio oli, että rasvapitoisuus vaikutti kielteisesti kermajuustojen miellyttävyyteen. Miellyttävyyttä erityisesti lisäävä ominaisuus oli joko suolainen maku (edamjuustot) tai suolapitoisuus (kermajuustot). Kermajuustojen happamuus ja edamjuustojen täyteläisyys olivat myös yleisesti pidettyjä ominaisuuksia. Sen sijaan keltaisuus, kovuus, tahmeus ja flavorin kokonaisvoimakkuus jakoivat kuluttajien mielipiteitä eri juustotyypeissä.

Milk Coagulability

Tiina Kriščiunaite, Irina Stulova, Anastassia Taivosalo,
Tiiu-Maie Laht & Raivo Vilu

Renneting properties and composition of raw bulk milk collected from a large number of individual farms in Estonia were determined for the first time. Milk renneting characteristics of the individual samples and calculated mean values for separate farms varied in the wide range. Distinctive seasonal changes in milk rennetability and firmness of coagulum were observed.

Pooled milk from tank trucks and dairy silos originating from the same milkings was also analysed. Changes in whey proteins to casein ratio due to partial degradation of κ - and β -casein fractions in pooled milk from tank trucks and dairy silos in comparison with the farm milk were observed. Rennet flocculation time (RFT) of milk from dairy silos was one minute longer compared with that of milk from individual farms. In addition to the original milk composition and microbiological quality weak exogenous influencing factors encountered after milking at the farm and before processing at dairy plant (refrigerated transportation of milk from farms to dairy silos, milk vigorous pumping or any other mechanical treatment, occurrence of disinfectant residues etc.) also determine milk coagulability and should be considered.

It was shown that the important correlations between milk composition and renneting characteristics observed earlier in the case of milk from individual cows were essentially the same in case of bulk milk delivered for processing. Milk pH significantly correlated with curd firmness and RFT; curd firmness correlated also with protein content, κ -casein fraction in particular ($r = 0.45$). The data obtained could help dairies to evaluate raw milk quality parameters essential from the technological point of view and may be a motivation for careful selection of farms according to the suitability of their milk for cheesemaking.

The role of copper in the manufacture of Finnish Emmental cheese

Lourdes Mato Rodriguez, Tiina Ritvanen, Vesa Joutsjoki, Jyri Rekonen
& Tapani Alatossava

The manufacture of Emmental cheese vary depending on the place of origin. Typical Swiss Emmental is produced with raw milk using copper (Cu) kettles. In many industrialized countries Emmental cheese is manufactured using stainless steel kettles with or without addition of a Cu salt. The effects of added copper in the manufacture of Finnish Emmental cheese were studied. Consequently, cheeses were produced with or without the copper supplement and a facultative heterofermentative *Lactobacillus* strain *Lb. rhamnosus*, which is currently utilized as a protective culture in large-scale manufacture. Cheeses were examined at 1, 7, 30, 60 and 90 days from microbiological, chemical and sensory points of view. For microbiological analysis different agar media were employed, chemical analysis included the determination of copper content, organic acids and nitrogen content in different fractions. The sensory analysis of 90 days old cheeses were performed by an expert panel of the Finnish Food Safety Authority EVIRA using a quality scoring method. The counts from different agar media did not reveal important differences between cheeses. Organic acid production was affected by the presence of Cu in the cheeses. The addition of Cu to cheese-milk increased the level of primary proteolysis and retarded secondary proteolysis as measured by nitrogen content in different extracts after citrate fractionation of cheeses, in pH 4.4-SN and 5% PTA-SN, respectively. The presence of Cu appears to positively regulate the sensory characteristics of the cheese produced in our conditions, and in particular the consistency was affected significantly. The role of the *Lb. rhamnosus* Lc 705 protective strain has not been shown to have important effects on most of the parameters that influenced the final quality of the cheeses. Though the traditional plating systems for revealing the bacterial population during cheese manufacture did not reveal any drastic differences caused by the presence of Cu, the results from chemical and sensory analyses suggest that utilization of Cu plays a significant role in the regulation of bacterial physiological and biochemical activities, which in turn affect the sensory quality of Emmental cheese.

Juuston valmistus täyskonsentroidusta maitotiivisteestä

Terhi Aaltonen

Perinteinen juustonvalmistus on konsentroidintiprosessi, jossa rasva ja kaseiinikonsentroituvat rakeistoksi, heraproteiinien, laktoosin ja mineraalien erottuessa rakeistosta. Juuston valmistus täyskonsentroidintiprosessilla tapahtuu suodatus- ja haihdutusvaiheilla eikä perinteistä rakeiston muodostamista tehdä. Suodatus tekniikoiden kehittymisen myötä tuli mahdolliseksi erotella maidon proteiineja tehokkaammin. Mikro-suodatusta (MF) käyttämällä voidaan juuston pääyhdisteet, kaseiini ja rasva, konsentroida. Juustoa valmistettaessa täyskonsentroidusta tiivisteestä tulee tiivisteiden koostumus vakioita. Heraproteiinien poiston havaittiin aktivoivan maidon plasmiini aktiivisuutta ja parantavan sen lämmön kestävyyttä maidossa. Maitotiivisteiden laktoosin vakioinnissa tiivisteestä poistettiin laktoosia käyttämällä diasuodatusvaihetta. Poistettava laktoosi määrä riippuu valmistettavasta juustosta. Kalsiumpitoisuus vaikuttaa suoraan juuston rakenteellisiin ominaisuuksiin, liian korkea kalsiumpitoisuus saa aikaan juuston heroittumisen kypsytyksen aikana. Kalsiumpitoisuutta voidaan laskea suodattamalla, kunhan kalsium on ennen suodatusta muutettu liukenevaan muotoon hapattamalla. Juuston kuiva-aineeseen konsentroidun tiivisteiden viskositeettia voidaan hallita hapattamalla tiiviste ennen haihdutusta. Hapatus saa aikaan viskositeetin laskun, joka johtuu kaseiinimolekyylien pienenemisestä. Vakioidusta ja haihdutetusta tiivisteestä valmistettavan juuston ominaisuuksia tulee jatkossa selvittää. Erityisesti tulee selvittää kuinka korkea primääriproteolyysi, aktivoitunut plasmiini entsyymi ja juustomassaan jäävä juoksete vaikuttavat juuston ominaisuuksiin. Ja saadaanko juustoon riittävästi peptidaasiaktiivisuutta ehkäisemään juuston kitkeryyttä. Lisäksi hapatteiden käyttäytyminen täyskonsentroidussa juustossa tulee selvittää.

Structure modification of acid milk gels through protein cross-linking

Dilek Ercili-Cura, Martina Lille, Riitta Partanen,
Johanna Buchert & Raija Lantto

With the rise of obesity, fat-free or low-fat, low-calorie dairy products are gaining more share in the market, especially in developed countries. The challenge with low-fat dairy gels is poor texture as fat globules are one of the structural elements in, for example, plain yoghurt. Proteins, as well, are the main building blocks determining the textural and water holding properties of such dairy products. Modification of protein matrix, which is mainly formed of physical protein-protein interactions, directly by introducing covalent bonds within or between protein clusters by using enzymes is one method to improve structural properties of fat-free or reduced-protein milk gels.

Tyrosinases and transglutaminases modify morphological and functional properties of milk proteins by creating inter- or intra-molecular covalent bonds and/or by modulating certain amino acid residues. However, extensive knowledge on complex colloidal structure of milk proteins is needed in order to tailor them toward better functionality. We studied the impact of tyrosinase and transglutaminase-induced modification of caseins and casein micelles on the structure of acid-induced milk gels. Interestingly, different structural changes were attained depending on the enzyme and substrate. In heat-treated milk, even though the two enzymes cross-linked to a similar extent, they affected the protein interactions in the gel network, thus the texture, differently. Both the size of the protein particles forming the gel network and the size of the pores were smaller in enzyme-treated samples than the controls. Transglutaminase treatment prevented the spontaneous syneresis and increased the water-holding capacity of the gels.