

# KEEMIA- JA MATERJALITEHNOLOOGIA TEADUSKONNA TOIDUAINETE INSTITUUDI TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2011

## 1. Instituudi struktuur

Instituudi direktor Raivo Vokk

- Toiduteaduse õppetool, Chair of Food Science, Raivo Vokk
- Toidutehnoloogia õppetool, Chair of Food Technology, Toomas Paalme

## 2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

(NB! punktid 2.1- 2.6 täidab struktuuriüksus)

### 2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide

#### 2.1.1 teadustöö kirjeldus (*inglise keeles*)

##### **Molecular mechanisms controlling glutathione accumulation in yeast** (*Ildar*

*Nisamedtinov, Kertti Oruments*) Glutathione is an important thiol peptide which has found application in a wide range of industrial practices, including pharmaceutical industry, cosmetics and food production. Microbiological synthesis in yeast is currently the most promising method for industrial glutathione production. The aim of this project is to gain insights into the regulation mechanisms of glutathione biosynthesis and accumulation in yeast *Saccharomyces cerevisiae*.

##### **Study of microbial physiology and growth space** (*Kaarel Adamberg, Liisa Arike*). For the

studies of cell physiology and growth space following methods were developed and applied: a) sequential parallel cultivation for fed-batch processes to screen out technological parameters or testing media (patent application in progress), b) quantitative omics methods to measure protein, mRNA and metabolite levels inside (metabolites also outside) the cells., c) data handling methods for omics datasets and single cell modelling, d) experiments of multicomponent media development for high yield cultivation of *Lactococcus lactis* and *Escherichia coli* cells.

**Studies in nutrition** (*Raivo Vokk, Tagli Pitsi*). Continuous updating of internet based nutrition program <http://tap.nutridata.ee>. Application of the program for nutritional studies of Estonian population.

##### **Microbial consortia during sourdough fermentation** (*Inga Sarand, Ene Viiard, Mariana*

*Bessmeltseva*). The changes in sourdough consortia during continuous recycling of rye sourdough at different cycle conditions were carried out. Results demonstrated the importance of cycle conditions on microbial composition of sourdough and that initial flour microflora dominating during first sourdough cycles is completely replaced by sourdough bacteria present in flour in very small numbers.

**Probiotics, prebiotics and synbiotics; Gastrointestinal tract simulator** (*Signe Adamberg, Ingrid Sumeri*). The gastrointestinal tract simulator (GITS) was used for comparative survival studies of lactic acid bacteria in semi-hard cheese and selection of acid-, bile- and digestive-enzyme resistant strains. Significant differences in survival of different species and genotypes of lactic acid bacteria and between of *L. casei/paracasei* as the dominating NSLAB species in GITS were shown (Paper accepted for publications). The growth and acid production in skim milk vs MRS broth, antibiotic sensitivity and resistance against three different bile preparations (native vs reconstituted bile or bile salts) of selected LAB strains from cheese were studied. In another study GITS was used to evaluate the synbiotic mixtures containing selected strains of lactobacilli and bifidobacteria and mixed prebiotic substrates. The dilution phase of the simulator was prolonged up to 24 hours to simulate the large intestine phase.

**Bioactive compounds in plant material** (*Tiina Lõugas*) Marine algae contain polysaccharides with a long tradition of use as texture modifiers in foods, but some species of algae also contain potent antioxidants, which, however, are currently not used as functional food ingredients. Various species of red and brown algae have been screened for their ability to scavenge free radicals using both the TEAC and ORAC assays and also for inhibition of accelerated lipid oxidation in model food systems using formation of thiobarbituric acid-reactive substances (TBARS). Also the experiments with furcellaran beads to encapsulate  $\beta$ -carotene from sea buckthorn berries are going on (self-life tests). The experiments with sea buckthorn berries grown in 2009 and 2010 have been completed.

**Phase transitions in food** (*Katrin Laos, Anna Mihhalevski, Tiina Klesment*) In order to characterize the rye starch retrogradation and bread staling the experiments were performed with  $^{13}\text{C}$  CP MAS NMR,  $^1\text{H}$  NMR ja XRD methods. NMR and XRD spectra show the re-crystallisation of starch during staling. Comparative analysis was carried out with amylopectin, amylose and isolated rye starch in DMSO (dimethylsulfoxide) to identify the rye starch structure. For ice-cream experiments the lactose crystallization processes were investigated by polarized microscope. The influence of freezing velocity and storage temperature (-15C, -20C and -35C) on lactose crystallization from different concentrations of sucrose-lactose solutions has been studied.

**GC-olfactometry** (*Kristel Kaseleht*) Introduction of SPME GC-olfactometry methods in food analysis, development of methods for training of olfactometry assessors and using the trained panel for aroma analysis of kvass, spices.

**Vitamer analysis in food** (*Kristel Hälvin, Ildar Nisamedtinov*). The UPLC/MS isotope dilution method was optimized for determination of water soluble vitamins B1, B2, B3, B5, B6. Preparation of patent application P201100051 “**Method and kit for simultaneous determination of the activity of B-complex vitamins in food**” from 18.07.2011 (application is pending).

### 2.1.2 aruandeaastal saadud tähtsamad teadustulemused (*inglise keeles*)

**I. Nisamedtinov:** Studies on glutathione accumulation of yeast. Accumulation of glutathione in response to over-expression in *S. cerevisiae* was studied. The over-expression of *YAP1* resulted in intracellular glutathione level over two times higher than in the parent strain. Transcript analyses revealed that, in addition to the genes of glutathione biosynthesis (*GSH1* and *GSH2*), the expression levels of genes in the cysteine biosynthesis pathway (*CYS3* and *CYS4*) were also significantly higher in the *YAP1* over-expressed strain. This suggests that *YAP1* over-expression affects glutathione accumulation via the transcriptional activation of both cysteine and glutathione biosynthesis genes.

**K. Adamberg:** Label-free methods for the quantification of proteins in the cell were introduced and practiced, simplified single cell models for *Lactococcus lactis* and *Escherichia coli* developed to simulate and analyse relationships between cell cycle and metabolic pathways.

### 2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

Kaseleht, K.; Paalme, T.; Mihhalevski, A.; Sarand, I. (2011). Analysis of volatile compounds produced by different species of lactobacilli in rye sourdough using multiple headspace extraction. *International Journal of Food Science & Technology*, 46(9), 1940 - 1946.

Mihhalevski, Anna; Sarand, Inga; Viiard, Ene; Salumets, Airika; Paalme, Toomas (2011). Growth characterization of individual rye sourdough bacteria by isothermal microcalorimetry. *Journal of Applied Microbiology*, 110(2), 529 - 540.

Roots, O.; Kiviranta, H.; Pitsi, T.; Rantakokko, P.; Ruokojärvi, P.; Simm, M.; Vokk, R.; Järv, L. (2011). Monitoring of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and polychlorinated biphenyls in Estonian food. *Proceedings of the Estonian Academy of Sciences. Chemistry*, 60(3), 193 - 200.

Koppel, Kadri; Timberg, Loreida; Salumets, Airika; Paalme, Toomas. (2011). POSSIBILITY FOR A STRAWBERRY JAM SENSORY STANDARD. *Journal of Sensory Studies*, 26(1), 71 - 80.

Lahtvee, P.-J.; Adamberg, K.; Arike, L.; Nahku, R.; Aller, K.; Vilu, R. (2011). Multi-omics approach to study the growth efficiency and amino acid metabolism in *Lactococcus lactis* at various specific growth rates. *Microbial Cell Factories*, 10

### 2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

2.4 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

### 2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

Aruandeaasta tähtsamad finantseerimisallikad olid 4 ETF granti ja Sihtfinantseeritav teema „Toidusüsteemide bioloogia ja füüsika“

**2.6** Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

**2.7** Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused (*Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel*)

- Haridus- ja Teadusministeerium

sihtfinantseeritavad teemad:

- **T090**, Toidu süsteemibioloogia ja füüsika, Paalme Toomas

baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):  
riiklikud programmid:

- Teiste ministeeriumide poolt rahastatavad riiklikud programmid:

- Uuriija-professori rahastamine:

- SA Eesti Teadusfond

grandid:

- ETF8165, Escherichia coli atsetaadi metabolismi kvantitatiivne kirjeldamine bioprotsesside optimeerimiseks, kasutades aktseleerostaatseid paralleelkultivatsioonisüsteeme, Adamberg Kaarel
- ETF7112, Toiduainete vananemine ja stabiilsus, Laos Katrin
- ETF7570, BIOAKTIIVSED KOMPONENDID TAIMSES TOORMES, Lõugas Tiina
- ETF7323, Keskkonnatingimuste mõju glutatiooni akumulatsioonile ja ainevahetusele Saccharomyces cerevisiae rakkudes, Nisamedtinov Ildar

ühisgrandid välisriigiga:

järeldoktorite grandid (SA ETF ja Mobilitas):

tippeadlase grandid (Mobilitas):

- Ettevõtluse Arendamise SA

eeluuringud:

arendustoetused:

- SA Archimedesega sõlmitud lepingud

infrastruktuur (nn „mini-infra“, „asutuse infra“):

- AP090, Toidu süsteemibioloogia ja füüsika, Paalme Toomas

Eesti tippkeskused:

riiklikud programmid:

muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

- EL Raamprogrammi projektid:

Osalemine EL 7. Raamprogrammi projektis: Qualivo?: The development of a next generation probiotic supplement for treatment and prevention of antibiotic associated diarrhoea (AAD) leingupartnerina Signe Adamberg

- Välisriiklikud lepingud:

**2.8** Struktuuriüksuse töötajate poolt avaldatud sihtfinantseeritava teadusteema taotlemisel arvestatavad eelretsenseeritavad teaduspublikatsioonid (*ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1*).

1.1 (10 artiklit)

Kaseleht, K.; Paalme, T.; Mihhalevski, A.; Sarand, I. (2011). Analysis of volatile compounds produced by different species of lactobacilli in rye sourdough using multiple headspace extraction. *International Journal of Food Science & Technology*, 46(9), 1940 - 1946.

Kaseleht, K.; Leitner, E.; Paalme, T. (2011). Determining Aroma-active Compounds in Kama Flour Using SPME-GC/MS and GC-Olfactometry. *Flavour and Fragrance Journal*, 26(2), 122 - 128.

Mihhalevski, Anna; Sarand, Inga; Viiard, Ene; Salumets, Airika; Paalme, Toomas (2011). Growth characterization of individual rye sourdough bacteria by isothermal microcalorimetry. *Journal of Applied Microbiology*, 110(2), 529 - 540.

Roots, O.; Kiviranta, H.; Pitsi, T.; Rantakokko, P.; Ruokojärvi, P.; Simm, M.; Vokk, R.; Järv, L. (2011). Monitoring of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and polychlorinated biphenyls in Estonian food. *Proceedings of the Estonian Academy of Sciences. Chemistry*, 60(3), 193 - 200.

Koppel, Kadri; Timberg, Loreida; Salumets, Airika; Paalme, Toomas. (2011). POSSIBILITY FOR A STRAWBERRY JAM SENSORY STANDARD. *Journal of Sensory Studies*, 26(1), 71 - 80.

Nahku, Ranno; Peebo, Karl; Valgepea, Kaspar; Barrick, Jeffrey E; Adamberg, Kaarel; Vilu, Raivo (2011). Stock culture heterogeneity rather than new mutational variation complicates short-term cell physiology studies of *Escherichia coli* K-12 MG1655 in continuous culture. *Microbiology*, 157, 1204 - 1210.

Orumets, Kerti; Kevvai, Kaspar; Nisamedtinov, I; Tamm, T; Paalme, T. (2011). YAP1 over-expression in *S.cerevisiae* enhances glutathione accumulation at its biosynthesis and substrate availability levels. *Biotechnology Journal*, 1

Nisamedtinov Ildar; Kevvai Kaspar; Orumets Kerti; et al. 2011 Metabolic changes underlying the higher accumulation of glutathione in *Saccharomyces cerevisiae* mutants. *APPLIED MICROBIOLOGY AND BIOTECHNOLOGY*, **1029-1037**

Valgepea, K.; Adamberg, K.; Vilu, R. (2011). Decrease of energy spilling in *Escherichia coli* continuous cultures with rising specific growth rate and carbon wasting. *BMC Systems Biology*, 5, 106

Lahtvee, P.-J.; Adamberg, K.; Arike, L.; Nahku, R.; Aller, K.; Vilu, R. (2011). Multi-omics approach to study the growth efficiency and amino acid metabolism in *Lactococcus lactis* at various specific growth rates. *Microbial Cell Factories*, 10

1.2 (7 artiklit)

Vokk, R.; Lõugas, T.; Mets, K.; Kravets, M. (2011). Dill (*Anethum graveolens* L.) and Parsley (*Petroselinum crispum* (Mill.) Fuss) from Estonia: Seasonal Differences in Essential Oil Composition. *Agronomy Research*, 9, 515 - 520.

Koppel, K.; Chambers, E. IV; Chambers, D.H. (2011). Flavour and Acceptance of Estonian Cheeses. *Agronomy Research*, 9(S2), 409 - 414.

Kirs, Evelin; Pall, Raili; Martverk, Kaie; Laos, Katrin (2011). Physicochemical and melissopalynological characterization of Estonian summer honeys. *Procedia - Food Science*, 1, 616 - 624.

Kaseleht, K., Paalme, T., Nisamedtinov, I. (2011). Quantitative Analysis of Acetaldehyde in Foods Consumed by Children using SPME/GC-MS(Tof), On-fiber Derivatization and Deuterated Acetaldehyde as an Internal Standard. *Agronomy Research*, 395 - 401.

Timberg, L.; Koppel, K.; Kuldjärv, R.; Paalme, T. (2011). Sensory and chemical properties of Baltic sprat (*Sprattus sprattus balticus*) and Baltic herring (*Clupea harengus membras*) in different catching seasons . *Agronomy Research*, 9(S2), 489 - 494.

Laos, Katrin; Kirs, Evelin; Pall, Raili; Martverk, Kaie (2011). The crystallization behaviour of Estonian honeys . *Agronomy Research*, 9, 427 - 432.

Klesment, Tiina; Stekolštšikova, Jelena; Laos, Katrin (2011). The influence of hydrocolloids on storage quality of 10% dairy fat ice cream. *Agronomy Research*, 9, 403 - 408.

### 1.3 (1 artikkel)

Laos, Katrin; Mihhalevski, Anna; Kivima, Evelin; Klesment, Tiina (2011). Toidukristallide kirev maailm. *Horisont*, xxx [ilmumas]

### 2.1

### 2.2

### 3.1

### 3.2

### 3.3

### 4.1

### 5.1

**2.9** Struktuuriüksuses kaitstud doktoriväitekirjade loetelu (*NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu*)

**Ingrid Sumeri**, toiduainete instituut

Teema: *The Study of Probiotic Bacteria in Human Gastrointestinal Tract Simulator* (Probiootilised bakterid inimese seedetrakti simulaatoris)

Juhendaja: prof Toomas Paalme

Kaitses: 22.06.2011

Omistatud kraad: filosoofiadoktor (keemia- ja materjalitehnoloogia)

**Kadri Koppel**, toiduainete instituut

Teema: *Food Category Appraisal Using Sensory Methods* (Toidukategooriate väärimine kasutades sensoorseid meetodeid)

Juhendaja: prof Toomas Paalme

Kaasjuhendaja: prof Edgar Chambers IV

Kaitses: 15.12.2011

Omistatud kraad: filosoofiadoktor (keemia- ja materjalitehnoloogia)

**2.10** Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu (*ETIS-e kaudu esitatud taotluste alusel*)

**2.11** Struktuuriüksuses loodud tööstusomandi loetelu

### **3. Struktuuriüksuse infrastruktuuri uuendamise loetelu**

- Laboratoorne nõudepesumasin, 4.01.2011, 9 267 €
- Pealtaetava autoklaavi kmpl., 14.01.2011, 7 030 €
- Eestlaetava autoklaavi kmpl., 14.01.2011, 20 452 €
- Veepuhastussüsteem pöördosmoos, 14.01.2011, 5 752 €
- Jahutusega inkubaator FRIOCELL, 14.01.2011, 5 305 €
- Inkubaator INCUCCELL, 14.01.2011, 2 732 €
- Inkubaator INCUCCELL, 14.01.2011, 2 732 €
- 200L kuivatuskapp sundventilat, 14.01.2011, 2 695 €
- 200L kuivatuskapp sundventilat, 14.01.2011, 2 695 €
- 200L kuivatuskapp sundventilat, 14.01.2011, 2 695 €
- 100L kuivatuskapp sundventilat, 14.01.2011, 1 534 €
- 100L kuivatuskapp sundventilat, 14.01.2011, 1 534 €
- 100L kuivatuskapp sundventilat, 14.01.2011, 1 534 €
- 100L kuivatuskapp sundventilat, 14.01.2011, 1 824 €
- Valgusmikroskoop CX21 FS1-3, 14.01.2011, 1 406 €
- Valgusmikroskoop CX21 FS1-3, 14.01.2011, 1 406 €
- Valgusmikroskoop CX21 FS1-3, 14.01.2011, 1 406 €
- Valgusmikroskoop CX21 FS1-3, 14.01.2011, 1 406 €
- Valgusmikroskoop CX21 FS1-3, 14.01.2011, 1 406 €
- Gaasipõletid 20 tk (a 421,81), 14.01.2011, 8 436 €
- Eestlaetav nõudepesumasin, 27.01.2011, 3 600 €
- Kombiahi LINOX alusega, 27.01.2011, 2 104 €
- Kiirjahutus-külmutuskapp, 27.01.2011, 3 744 €
- Pacojet / IV-303, 27.01.2011, 2 809 €
- Külmkamber, keldris IV-012, 27.01.2011, 3 085 €