Annual report for SNS research projects

Submit the report before March 1st to: sns@slu.se
The report should not exceed 1500 words (including words in the template).

1. Project title: Valorization of wood biorefinery products into novel functional hydrocolloids (WOOD-PRO)
2. Reporting year: 2017

3. Project coordinator: Assistant Professor Kirsi S. Mikkonen
Address: Department of Food and Nutrition, P.O. Box 66, 00014 University of Helsinki
Email: kirsi.s.mikkonen@helsinki.fi

Activities during the reporting year:

4. Description of the activities during the reporting year:

Research was carried out according to the project plan. Nanocelluloses and hemicelluloses with different structure, morphology, and purity were studied for the preparation of emulsions and gels. Hardwood nanocellulose and softwood hemicellulose were selected for the preparation of emulgels, in which the continuous phase of an emulsion was gelated to form an elastic network of hydrocolloids surrounding the dispersed phase: oil droplets. The functionality of nanocellulose and hemicellulose was tested at varying temperature and relative humidity. Storage tests were performed to reveal the long-term physical stability of the compositions.

Cellulose nanofibers have been prepared by means of ultrafine grinding approach from two different sources of raw material. First from carrot residue, were the purification was carried out prior to the mechanical fibrillation. Secondly, wood nanofibers were prepared using dissolving pulp as starting material. The characterization during and after fibrillation included optical microscopy, viscosity measurements, and the measured energy demand of the mechanical grinding.

The WOOD-PRO project has been supplemented with work from the NORCEL (The NORwegian nanoCELlulose Technology Platform) and the NanoVisc project (Development of high-performance viscosifiers and texture ingredients for industrial applications based on Cellulose Nanofibrils (CNF)), both run at RISE PFI and fully or partly funded by the Research Council of Norway. Different qualities of nanocelluloses have been produced and characterized and samples have been shared with the University of Helsinki for further studies. Doctoral student Ragnhild Aaen (RISE PFI, Norway), employed in the NanoVisc project, made a research visit at the UH laboratory, Finland in order to continue work started during her first visit in 2016. Emulsions stabilized with nanocelluloses and galactoglucomannan and mixtures thereof have been studied.

A project meeting was organized within the American Chemical Society Meeting in San Francisco, 5.4.2017. In addition, a teleconference was organized on 29.11.2017 to plan the joint research work.
Place and date for the activities:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Place (country) for the activity</th>
<th>Duration (date)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research visit by Ragnhild Aaen</td>
<td>UH, Finland</td>
<td>15.1.-17.2.2017</td>
</tr>
<tr>
<td>Project meeting</td>
<td>San Francisco, USA</td>
<td>5.4.2017</td>
</tr>
<tr>
<td>Teleconference</td>
<td>Skype</td>
<td>29.11.2017</td>
</tr>
</tbody>
</table>

6. Project status
- Does the project develop according to the research plan? Please elaborate.
- Does the project deviate from the plan? Please elaborate.

The project is following the research plan and proceeding accordingly. Different nanocelluloses and hemicelluloses are being tested for their functionality in emulsions, gels, and emulgels. Several nanocellulose qualities with different charge density have been produced and characterized. Charged nanocelluloses were able to stabilize oil-in-water emulsions of low oil content at very low concentrations. The combination of nanocelluloses and galactoglucomannans to stabilize emulsions show promising results both for the physical and the oxidative stability of the emulsions. The aim is to develop new advanced uses for forestry-based raw materials by combining efforts from three Nordic research groups. The project produces scientific understanding of the effect of structure, morphology, and purity of nanocelluloses and hemicelluloses on their emulsifying and gel forming capacity that can be used in wide perspective to predict the behavior of different plant-based materials in aqueous and dispersed systems as well as on interfaces. Both scientific and practical knowledge of the range of functional conditions is obtained. With this knowledge, we are able to direct the processes of hemicellulose isolation and nanocellulose manufacturing to yield the best results for the industrial applications. During the last project year, concepts will be provided for novel products applying the best functioning nanocelluloses and hemicelluloses in food (pastes, dressings, beverages, to name a few), pharmaceutics (emulsions, gels, emulgels), and cosmetics (skin creams, lotions).
Results during the reporting year:

7. List the published outputs during the reporting year (peer-reviewed articles, other publications):


8. Other practical outputs during the reporting year (e.g. websites, policy recommendations, conferences, large-scale project applications etc.)

The UH partner established a website, blog, and Twitter account to disseminate the results:

https://www.helsinki.fi/food-materials-science

Conference presentations:

9. Economic overview for the reporting year

<table>
<thead>
<tr>
<th>Received grant from SNS for the reporting year:</th>
<th>Specify currency:</th>
</tr>
</thead>
<tbody>
<tr>
<td>500000</td>
<td>SEK</td>
</tr>
</tbody>
</table>

**Costs**

<table>
<thead>
<tr>
<th></th>
<th>SNS funding</th>
<th>External funds</th>
<th>Total</th>
<th>SNS funding (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel and hotel</td>
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<td>144722</td>
<td>148158</td>
<td>2</td>
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<tr>
<td>Meeting costs</td>
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<td>0</td>
<td>3325</td>
<td>100</td>
</tr>
<tr>
<td>Communication</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Consumables</td>
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<td>120000</td>
<td>158816</td>
<td>24</td>
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<tr>
<td>Salary</td>
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<td>2150000</td>
<td>2385000</td>
<td>10</td>
</tr>
<tr>
<td>(Other costs (specify below))</td>
<td>0</td>
<td>240769</td>
<td>240769</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total SUM</strong></td>
<td><strong>110829</strong></td>
<td><strong>2035993</strong></td>
<td><strong>2146822</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

Transfer of SNS funds to project partners

<table>
<thead>
<tr>
<th>Sum</th>
<th>Receiver of (partner) and reason for transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>356902</td>
<td>RISE, Trondheim, Norway. This partner's share of budget for 2016 and 2017.</td>
</tr>
<tr>
<td>356902</td>
<td>LTU, Luleå, Sweden. This partner's share of budget for 2016 and 2017.</td>
</tr>
</tbody>
</table>
Comments to the economic overview:

The project has allocated a large part of costs to the external funds and requests to transfer the remaining budget to the current year's budget.

The other costs covered by the external funding consist of grants to master students, costs of small equipment, and fees for open access publication.

I hereby declare that the above statements are true to the best of my knowledge

Signature of the project coordinator

[Signature]  University of Helsinki  27.2.2018
(Signature)  (Institution)  (Day / Month / Year)

Signature of head of research institution

[Signature]  Univ. of Helsinki  27/2/2018
(Signature)  (Institution)  (Day / Month / Year)

MARINA HENONEN, head of the department
(Printed name, function)