PPP Project Final Report 2018
The PPP-projects that have been established under the direction of the top sectors and will be completed before 1 March 2019 must submit a technical and financial final report. This format is to be used for the technical final report.
The report will be published on the websites of the TKIs/top sector, excluding the blocks 'Approval coordinator/consortium' and 'Changes to the original project plan' . Please ensure that no confidential matters are left in the remaining blocks.

General information	
PPP number	**AF16107**
Title	Novel starch based adhesives
Theme	Circulair
Executive knowledge institution(s)	WFBR
Research project leader (name + e-mail address)	Maurice.essers@wur.nl
Coordinator (on behalf of private parties)	Agrana
Government contact person	Jan van Esch
Total project size (k€)	480
Address project website	content/uploads/2017/06/AF-16107-Novel-Starch-Based-Adhesives.pdf
Start date	01-02-2017
End date	31-03-2019

Approval coordinator/consortium *The report should be discussed with the coordinator/the consortium. The TKIs appreciate being informed of possible feedback on the report.*	
The coordinator has assessed the report on behalf of the consortium	X approved □ rejected
Feedback from the consortium coordinator on the report	positive

Short description/aim PPP
What is going on and how is this project involved?
What will be delivered by the project and what will be the effect of this?

The purpose of this project is to develop new generation of starch based adhesives that enable to make new generation starch based adhesives that can replace synthetic non-biodegradable polymers such as polyvinyl alcohol. A renewable and cheaper alternative for PVOH, based on starch, would be very desirable from a commercial and environmental point of view. The currently used starch derivatives still have a lack in performance. Hence we need to restructure starch in such a way that enhanced functionality is created. This can be done via reactive extrusion. This technique allows to combine gelatinisation of the starch and modifying it simultaneously. By doing this, remodelling of the starch takes place which can induce new functionalities. The application performance will be investigated by our partners Cordial and Agrana in bagging glue formulations. For this rheological characteristics as well the adhesive properties of the extruded starch derivatives will be determined and compared with its counter type PVOH.

Changes to the original project plan and follow-up	
Have there been any changes in the consortium/project partners? If yes please explain	no
Have there been any changes in the project set up? If yes please explain.	no
Do you expect a patent application to arise from this PPP? If yes please explain	Yes, we believe that the knowledge build up will lead to new intellectual property.
Do you expect spin offs to arise from this PPP? (including new projects) If yes please explain	Yes, it is foreseen to continue this program
in how many years will the private parties use results from this project in practice?	We believe in 2 years
How has the project contributed to developments within the involved knowledge institution(s)? (e.g. scientific breakthroughs, new collaborations etc)	Yes, there has been made significant progress in the modification of biopolymers via extrusion; this is not evident as it bioplymers are more prone for decomposition then synthetic polymers.
What will be the follow up of this project?	The follow up program will be an extension and broadening of the scope of the current project

Achieved Results

Describe the deliverables of the project?

In this project it was foreseen to combine extrusion of starch in combination with modification. Hence we selected two types of modification. Due to the modification, it was observed rheology of the biopolymer changed drastically. This caused fluctuations of the throughput during the process and even caused decomposition of the biopolymer. (Biopolymers are far more prone for decomposition then its synthetic counter types.) On lab scale one will not observe these problems but these will immediately emerge when scaling up. Furthermore, It turned out that this is also effected by the source/type of starch, e.g. high amylopectin starches are more difficult to process then other native starches.
Hence we needed to put much effort on selecting the right process conditions for modification and changing the configuration of the screw elements of the extruder. We did not expect this in the beginning. We finally succeeded in this and we could produce several different samples on pilot level. The knowledge build up, gained in this project, is applicable on other types of modifications and will help us to develop and to produce novel derived biopolymers with enhanced functionality.

What is the effect and for whom?

Less effort in the project was put on the structural-functional relationship of the emerging products. Still we able to perform the first application trials. First insight point out that optimization is required; e.g. degree of substitution needs to be changed.
Furthermore, for the starch producing company Agrana it was of high importance to see the effect between lab scale and pilot trials. It was observed that our extrusion equipment is close in performance in comparison to the extruders on production level; our equipment enables to investigate issues that emerge on production level. For WFBR this project was a breakthrough in the modification of biopolymers via extrusion. Hence the idea is to continue and apply this knowledge on other types of modifications and applications.

Which project parts differed from the original plan and what was the reason for this?

It was not foreseen (in the beginning of the project)that reactive (modifying) extrusion of biopolymers is very complex. Hence we needed to solve these issues first in order to continue. We finally succeeded in this but it had the consequence that another work package (granular

modification) got less attention. This was needed to guarantee the continuation of the project.

Deliverables (description of the most important products and their target group)

As explained above, during this project we observed many problems during reactive extrusion. We needed to solve them; the idea generation which was needed for this created innovation, which might be patentable. This is what we want to investigate further on.

Another important asset in this project has been development of analytical procedures and methods. Especially much effort was given to the determination of the molecular weight of the products; for biopolymers such as starch, no real good standard methods exists. Hence we needed to put effort on this.

During this project we have given approximately 10 internal presentations. It is foreseen to present a part of this externally as well.

Number of delivered products (in an appendix, please provide the titles and/or description of the products or a link to the products on public websites)

Academic articles	Reports	Articles in journals	Introductions/workshops
We consider a patent application	We mutual decided to display all results in a final power point presentation	Not yet (patent application is considered)	This can be done after filing a patent

Appendix: Names of the products or a link to the products on a public website