



PPP Annual Report 2019

PPP projects which are under supervision of the "Topsectoren" must report annually on the scientific content and financial progress. This form is used to report the progress of the content of the project. PPP projects that finish in 2019 should make use of a different form: "PPP-final report."

The annual report will be published on the TKI / topsector website. Therefore, please ensure that there is no confidential information in the annuareport.

General information	
PPP-number	TKI-AF-16011
Title	Plant Meat Matters. Towards a next generation meat analogues.
Theme	Topsector Agri & Food, Healthy and Safe
Implementing institute	Wageningen University & Research
Project leader research (name + e-mail address)	Ariette Matser Ariette.matser@wur.nl
Coordinator (on behalf of private partners)	Louis van Steijn, Meyn
Project-website address	https://www.wur.nl/en/Research-Results/kennisonline/AF16011-Plant-Meat-Matters.htm
Start date	1 January 2017
Final date	31 December 2021

Approval by the coordinator of the consortium

The annual report must be discussed with the coordinator of the consortium. The "TKI's" appreciate additional comments concerning the annual report.

Assessment of the report by the coordinator on behalf of the consortium:	<input checked="" type="checkbox"/> Approved <input type="checkbox"/> Not approved
Additional comments concerning the annual report:	

Summary of the project

Problem definition	<p>Plant Meat Matters builds the required scientific basis to understand the structuring process of meat analogues while including flavour components, fat and other ingredients. Together with partners that span the entire vegetable protein chain, this basis will be used to further develop technologies for making the next generation of consumer-accepted meat analogues with improved characteristics that can be produced more cost-effectively and will have reduced environmental impact compared to meat analogues currently available on the market.</p> <p>The high and increasing consumption of products from animal origin is one of the key factors making current food production routes insufficiently efficient to feed the growing, and more affluent world population. A route to reduce the consumption of those products is the development of plant-based analogues for meat or meat-like products. In recent years, Wageningen University and the Technical University of Delft jointly developed a novel technology for the</p>
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	production of fibrous, plant-based materials on nano to mesoscale, resembling the structure and bite of meat better than commercial products that are currently available to consumers. This fibrous material could, therefore, form the basis of the next generation of meat analogues.
Project goals	<p>Plant Meat Matters has the following vision and ambition towards a next generation of meat analogues:</p> <ul style="list-style-type: none"> • Reduced consumption of products from animal origin is a key step towards a sustainable diet and can be achieved by direct replacement by textured plant-based products • Ingredients necessary for meat analogues can be produced with higher efficiency, and reduced use of energy, water and chemicals when focusing on the right ingredients for meat analogues rather than on pure ingredients • Producing less waste by the production of meat analogues is possible by keeping food fresh for longer and on-demand production of meat analogues <p>Project objectives:</p> <ul style="list-style-type: none"> • Improve scientific basis for next generation meat analogues - Product quality: water binding, fat, flavours, etc. - Ingredient flexibility & possibilities for processing • Further development of technologies and ingredients for meat analogues - Consumer accepted and improved characteristics - Cost-effective process with reduced environmental impact • Enable partners to develop and produce better meat analogues, ingredients, flavouring and equipment. <p>The Plant Meat Matters consortium consists of Meyn Food Processing Technology, Avril, Ingredion, Givaudan, saturn petcare, Nutrition & Santé SAS, De Vegetarische Slager, Unilever R&D Vlaardingen, Rival Foods, Wageningen University Food Process Engineering and Wageningen Food & Biobased Research.</p>

Results	
Planned results 2019	<p>In January 2017, Plant Meat Matters started with eight industrial partners, Wageningen Food & Biobased Research and Wageningen University. In 2018, a new partner joined the consortium; Rival Foods. The project is divided into 8 work packages (WPs). WP 1 and 2 focus on bridging the technology gap and build on background knowledge and results from the 6 other WPs. WP 3-6 focus on understanding the structuring process by in-depth research involving PhD students. Knowledge transfer is addressed in WP 8 focussing on communication and dissemination.</p> <p>Planning is done on two levels:</p> <ul style="list-style-type: none"> - An overall planning, as described in the project plan, with deliverables for the entire duration of the project. In 2019, together with the partners, this planning was evaluated and updated when necessary. - A detailed planning for each WP, discussed in the consortium. <p><u>Below a summary is given of the main results achieved in 2019.</u></p>
Achieved results 2019	<p>The main achieved results for 2019 are described below for the different work packages.</p> <p><u>WP 1 Upscaling and maturing shear cell technology</u> The aim of WP 1 is to develop shear cell technology for high-quality meat analogues and to deliver full-scale solutions for meat analogue production. In 2019, main focus was on understanding the impact of process parameters on the product quality of meat analogues made with shear cell technology. The developed R&D test model for shear cell</p>

technology that can be scaled up towards industrial application was used for this, as with this system, robust and reproducible results can be achieved. Temperature, time and shear rate were varied in a process parameter study, using a Design of Experiments. The effect on the formation of fibres in soy/gluten mixtures was investigated. The results are currently being evaluated and will be discussed with the partners early 2020. The results will serve as input for upscaling and maturing shear cell technology.

WP 2 Developing meat analogue products with excellent taste and texture and investigating consumer acceptance of those products

The goal of WP 2 is to develop meat analogue proof of principle prototypes with excellent taste and texture for further development by the partners. In 2019, the major activities focussed on understanding the relation between ingredients and structure formation. In addition to the role of the proteins, the impact of other ingredients, like water, salts, starch, fat and flavours was studied, showing the complexity of the processes occurring in the shear cell. Special emphasis was on rheological properties of doughs during shearing and heating, as this can give more understanding of the processes in the shear cell. This will be continued in 2020. Together with WP 3, 4, and 5, the obtained knowledge of soy proteins is being applied to other types of plant-based protein-rich materials.

WP 3 Understanding the structuring potential of oilseeds, which includes the effect of fractionation

The aim of this WP is the understanding of structuring of oilseeds, including the effect of oil extraction and fractionation. In this WP, one PhD student finished her PhD thesis in 2018, and two other PhD students are currently active. One PhD student is focussing on the mild fractionation of rapeseed and sunflower kernel, to obtain fractions that can be used for meat analogues. The research showed that the fractionation process and the composition of the concentrates and isolates largely influence the structuring potential of these sources. The other PhD student is focussing on the mild fractionation of soy. Focus is on fractionation procedures (wet, mild, simplified), pH modifications and replacing NaOH with other buffers. The structuring properties of these fractions will be studied in the shear cell and linked with water holding capacity and viscosity. Scientific publications are in preparation.

WP 4 Investigating the structuring potential of protein concentrates and isolates from pulses and beans, including the effect of mild fractionation

This WP focusses on the development of dedicated functional ingredients for meat analogue applications based on pulses and beans. The aim is to integrate ingredient production and product assembly to make further savings in energy-, water- and raw material use. In 2019, the PhD student of this WP focussed his research on investigating the water holding capacity as a predictor for structuring potential of proteins from pulses. The relative swelling of proteins in mixtures appears to be a good prediction of the behaviour of the combined mixture. A scientific publication is submitted based on these results. In 2020, these results will be linked to the structuring potential of different fractions using shear cell technology.

WP 5 Understanding mechanical properties, juiciness and flavour release of structured protein systems

The aim of WP5 is to improve the juiciness of meat analogues produced with the shear cell by generating a better understanding of the underlying mechanisms that control juiciness. A PhD student is active in this WP. In 2019, the research on water holding capacity of mixed soy-gluten gels was extended to the effect of marinating meat analogues after structuring. This is used in industry for e.g. extruded meat analogues. Research focusses on the effect of pH and ionic strength on

	<p>the water uptake of soy-gluten meat analogues. The release of water will be studied as an indication for the juiciness of meat analogues and linked to the structure of the meat analogues. Scientific publications are in preparation.</p> <p><u>WP 6 Towards the development of plant-based alternatives for meat-derived ingredients in pet food</u> The aim of this WP is to research the possibilities for vegan pet food, using shear cell technology. Making vegan pet food gives rise to challenges that are similar to making products for human consumption, but has some additional requirements for texture, taste and nutrients. A PhD student is active in this work package. In 2019, experiments were performed to evaluate the effect of post-processing steps on the texture of shear cell products during shelf life. Pet food is usually sterilised in e.g. cans, where the product consists of chunks in a fluid. It was investigated if the textural properties of meat analogues made with shear cell technology are affected by sterilisation. The structure appeared to be softer, but chunks were intact in form. In 2020, focus will be on the impact of nutritional additives like vitamins and minerals on the texture formation of meat analogues, as for pet food, these components are essential to be present.</p> <p><u>WP 7 Sustainability analysis of various alternatives for meat</u> The aim of this WP is to make a sound sustainability analysis on the production of meat analogues and to investigate the efficiency in production chains for plant-based high protein foods. In 2019, exergy analysis was performed on shear cell technology with respect to the entire production chain. It was shown that shear cell structuring is efficient with respect to exergy loss, however, the main impact is in the fractionation step, not in the structuring step. Activities therefore focus on the impact of different fractionation processes on the sustainability of meat analogues. Together with WP 6 activities are started on the role of nutritional value in the sustainability of meat analogues (coupling nutrition to sustainability). These activities will be continued in 2020.</p> <p><u>WP 8 Communication and dissemination</u> This WP focusses on the internal and external communication and dissemination of Plant Meat Matters. In 2019, two general meetings and multiple WP meetings were organised where all partners were present. Plant Meat Matters resulted in various dissemination activities. Below you will find the dissemination in 2019. A second conference 'Science and Technology for Meat Analogues' will be organised in early 2021. The organisation will start in 2020 with special focus on the scientific results of different research groups working on meat analogues.</p>
Planned results 2020	<p>In 2020, the activities in Plant Meat Matters will be continued according to the overall planning described in the project plan and the detailed planning discussed with the partners for the different WPs. Special focus will be on:</p> <ul style="list-style-type: none"> - Scientific publications: multiple publications are foreseen, and presentations will be given at scientific conferences - Insight in relation ingredients – processing towards meat analogues: the results obtained in Plant Meat Matters will be combined to develop an overall hypotheses of the behaviour of proteins under shear and heat. This is relevant for shear cell technology, but also for other structuring technologies such as extrusion. - Interaction between WPs: in addition to the activities belonging to individual WP, many interactions are foreseen between the WPs, e.g. by transferring fundamental results to the more applied WPs, and by using insights from one WP in another WP.

Deliverables/products in 2019 (provide the titles and /or a brief description of the products/deliverables or a link to a website).
Below the products of 2019 are described, the full list can be found via the project website.

Scientific articles:

Meat alternatives: an integrative comparison, C. van der Weele, A.J. van der Goot, B.C van Mierlo, P. Feindt, M.J.A.S van Boekel, 2019, Trends in Food Science and Technology, 88: 505-512

Maltodextrin promotes calcium caseinate fibre formation through air inclusion, Z. Wang, B.L. Dekkers, R.M Boom, A.J. van der Goot, 2019, Food Hydrocolloids, 95: 143-151

Protein Oxidation and In Vitro Gastric Digestion of Processed Soy-Based Matrices, P. Duque-Estrada, C.C. Berton-Carabin, M. Nieuwkoop, B.L. Dekkers, A. E.M. Janssen A.J. van der Goot, 2019, Journal of Agricultural and Food Chemistry, 67: 9591–9600

External reports:

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Articles in professional journals/magazines:

See below

(Poster) presentations at workshops, seminars, or symposia.

Let's talk science, Plant-based proteins and latest research, Key Note lecture by A.J. van der Goot, Proveg Berlin, 20 March 2019

Functional Characteristics Of Mild Fractionated Soy Protein Processed At Different pH Value, Yu Peng. Presentation at conference: 2nd Innovations in Food Science and Technology, June 25-27, 2019, Amsterdam, The Netherlands

Toasting as a tool to improve the functional properties of fababean protein concentrate. Jan M. Bühler, Birgit L. Dekkers, Marieke E. Bruins, Atze Jan van der Goot. Poster presented at ISFRS (International Symposium on Food Rheology and Structure), 17-20 June 2019, Zurich, Switzerland

Confined compression to study juice release kinetics from meat (analogues). Steven Cornet. Oral presentation at ICEF 13, 23-26 September 2019, Melbourne, Australia

Effect of pH and ionic strength on the water holding capacity of model meat analogues. Steven Cornet, Atze Jan van der Goot, Ruud van der Sman. Poster presented at ICEF 13 23-26 September 2019, Melbourne, Australia

Texture profiling of wet foods for dogs and cats. Tran, TTTT, Wehrmaker AM, van der Goot AJ, Bosch G. Poster presented at 23rd Congress of the European Society of Veterinary and Comparative Nutrition, 18-20 September 2019, Turin, Italy

Impact of retorting and storage on physicochemical properties of a Couette cell meat analogue. Wehrmaker AM, Bosch G, van der Goot AJ. Presentation at 23rd Congress of the European Society of Veterinary and Comparative Nutrition, 18-20 September 2019, Turin, Italy

Toasting as a tool to improve the functional properties of fababean protein concentrate. Jan M. Bühler, Birgit L. Dekkers, Marieke E. Bruins, Atze Jan van der Goot, Poster presented at 33rd conference of The European Federation of Food Science and Technology (EFFoST), 12-14 November 2019, Rotterdam, The Netherlands

Functional properties of mild fractionated soy protein as related to the processing pH, Yu Peng, Poster presented at 33rd conference of The European Federation of Food Science and Technology (EFFoST), 12-14 November 2019, Rotterdam, The Netherlands

Effect of pH and ionic strength on the water holding capacity of model meat analogues. Steven Cornet, Atze Jan van der Goot, Ruud van der Sman. Poster presented at 33rd conference of The

European Federation of Food Science and Technology (EFFoST), 12-14 November 2019, Rotterdam, The Netherlands

Confined compression to study juice release kinetics from meat (analogues). Steven Cornet, Atze Jan van der Goot, Ruud van der Sman. Poster presented at 33rd conference of The European Federation of Food Science and Technology (EFFoST), 12-14 November 2019, Rotterdam, The Netherlands

TV/ radio / social media / newspaper:

Hoe groen is de vegaburger? Interview of Atze Jan van der Goot by Jeroen Koot, Financieel Dagblad, 5 January 2019

De grootste voedselrevolutie. Interview of Atze Jan van der Goot by Marc van Springel, 15 March 2019, HUMO,

Wie unser Essen in Labor new erfunden wird. Interview of Atze Jan van der Goot by Anke Fossgreen, Sonntagszeitung, Switzerland, 21 April, 2019

Raising the steaks. Interview of Atze Jan van der Goot by Marta Zaraska, Discover, April 2019, Interview Atze Jan van der Goot by Steven Smit NTR radio Focus, Radio 1, 12 June 2019, <https://www.nporadio1.nl/podcasts/dekennisvannu>

Geen spek maar bonen. Contribution of Atze Jan van der Goot to NTR TV program Kennis van Nu, 12 June 2019; https://www.npostart.nl/de-kennis-van-nu/12-06-2019/VPWON_1297949

In Groesbeek groeit de vegaburger van morgen. Contribution of Atze Jan van der Goot to article Financieel Dagblad & VPRO gids by Jeroen Koot, 15 June 2019, <https://www.ntr.nl/De-Kennis-van-Nu/19/tekst/Geen-spek-maar-bonen/384#content>, <https://fd.nl/futures/1303587/in-groesbeek-groeit-de-vegaburger-van-morgen>

Interview of Atze Jan van der Goot by Sami Emory, Wired, UK, 20 August 2019 <https://www.wired.co.uk/article/future-of-food-innovation-technology>.

Interview of Atze Jan van der Goot by Marini Witlox, RTLZ 22 August 2019 <https://www.rtlz.nl/life/lifestyle/artikel/4822471/vega-beyond-meat-supermarkten-hoogleraar-nepplees-plantaardig>

Future protein. Interview with Yu Peng and Konstantina Kyriakopoulou in Sanlian Life Weekly, Chinese Magazine, 14 Oct 2019 https://mp.weixin.qq.com/s?__biz=MTc5MTU3NTYyMQ==&mid=2650700173&idx=1&sn=7a737990698bd536b6931385bc20b8c8&chksm=5afc68a76d8be1b1f33b93e7d5fd533859d9d6a2f998a1e634d6295252cabd3818115644ea19&mpshare=1&scene=1&srcid=1118norAZJfRkJspEIMsokG&sharer_sharetime=1574084972932&sharer_shareid=9ea5f1cd44106dc9909c3a8af7648ec3&pass_ticket=wdwkqhU5HjR8qEHfzmoQWwtK71cInubJqrEbbAjA8a2b%2BbB2nHmF0Co%2ByziowdMN#rd

Plant-based meat offers the potential to create a radically different food chain. Interview of Atze Jan van der Goot by The Economist, <https://www.economist.com/international/2019/10/12/plant-based-meat-could-create-a-radically-different-food-chain>, 10 Oct 2019 (in French: <https://news-24.fr/la-viande-a-base-de-plantes-pourrait-creer-une-chaine-alimentaire-radicalement-differente/>) The Economist, October 12th 2019

Remaining deliverables (techniques, devices, methods, etc.):

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