ILSI 2021 Annual Symposium Session 3: Innovative Packaging

Transcript of the presentation, Fighting Plastic Pollution with Innovative Food Packaging, Nathalie Gontard, PhD, INRAE, France

I would like first to thank Stephane Vidry for inviting me. Stephane is a former colleague from the University of Montpellier in France. And also, I would like to thank also all the organizing committee. So, I will give you a few words about how innovation in food packaging can help fighting plastic pollution.

Okay. Here is a first slide. So, we know all that packaging is a key actor of food consumption. And this is a very important element for processing storage, transport, marketing, and also consumption between the field and the plates. But now we know also there is another step that is a little bit less positive. This is, after usage step up to waste management, and up also to find out as we will see a little bit later as up to the final fates of the materials.

So now we all are facing the issue of balancing the positive impact of packaging materials for reducing food waste and losses. And on the other end, the negative part, the negative impact of packaging materials and especially in our environment. And this is really one of the main issues we are currently facing. And this is also one of the reasons why the previous speaker, Carolyn Lock has just presented us these materials, which are bringing in new benefits for the benefits for the environment.

So maybe the food packaging has three key steps on its life cycle. And the benefit is mainly during the usage through each functional property, which of course we adapted to the food preservation. The negative impact is mainly during the production of these packaging. And of course, after the usage of these packaging materials. And we know that plastic packaging is bringing some very specific issues which are linked to the fact that these material, plastic materials have a very specific behavior, that is very different from the only other materials humans have used up to now.

They are not able to slowly solubilize like metal or glasses, for example, to mineralize water and soil. They are not able to biodegrade like all organic matters in order to reintegrate the carbon cycles. They have a very, very specific behavior and plastic materials are able to fragment to persist a very long time because this fragmentation take a very long time. They are able to diffuse and once they have reached the micro metric size, they can diffuse everywhere in the compartments, the environmental compartments.

And once they reach the nano metric size, they are able to translocate, which means to diffuse inside, to pass through the barrier of our organs and to diffuse inside the organs of living beings. And the results are that usually it means that life cycle environments are systematically and unfairly underestimated the environmental impact of plastic, and therefore favor plastic compared to all the other materials, whether they are papers, metal, glass and so on.

So, in our laboratory, we have decided to set up a strategy to develop new materials. What we call innovative materials that are not presenting the issue of fine particle pollution. So, the objective is really to develop materials that are fully biodegradable in natural condition at the very end, which means that they are presenting zero risk in term of particle plastic pollution, fine particle pollution of plastic waste.

And we have also decided to work only on non-food roll materials in order to not compete with food usage. And for that, we have used agricultural residues as raw materials for the production of polyhydroxyalkanoates. In fact, this is PHBV PH valerate as a bio source material, but nonfood sourced, which is bioprocess. It is fully biodegradable, and it can be bio-recyclable for the time being, we are really working on the... We are really working on making this pitch immaterial pitch a based material, more resistance for being able to be reused and recycled also via mechanical recycling process.

Okay. So, this is according to the plastic Europe feature in Europe, you can see that there is about one third of our plastic packaging waste that are incinerated, 16% land filled, 13% non-collected. There are only a few percent that are closed loop recycled. And then the rest that is called recycled. In fact, they are either down cycled or exported. So, at the end, if we look at the fate of our materials, this is more than 61% in Europe of our plastic packaging waste that are ending in our environments and are increasing our reservoir of micro and nano particles. And our objective is really to increase this part of bio-sourced and biodegradable and bio-recyclable also materials to increase this green here, this green arrow of materials.

So here it is, this is an example of materials we have developed. We used agricultural residues on one side, we are using liquid effluent like cheese whey or water from all washing and different type of agricultural residues as the fermentation substrate for the production of PHBV. And on the other end, we are using solid wastes which through vine shoots and so on that are going round. And in order to produce renew lignocellulose fibers.

Both are compounding together. And the structure is tailored in order to obtain the required mass transfer properties, which means water vapor bio-properties, oxygen properties but also carbon dioxide properties adapted to the food preservation. Because for each food is requiring very specific properties and having the highest bio possible is not the good solution for food. And the results are that we are currently using plastic biofilms that have too higher bio, and we are micro, or macro, perforated them. So, each materials need to be adapted to the requirements of the food in order to increase the shelf life of the food and reduce food loss significantly.

And then the materials obtained here. We have an example of these trays are fully compostable in natural conditions, which means that you can put it in your garden and matter will fully disappear in a few months in order to reintegrate the carbon, the natural carbon cycle. For the production of these PHA, we have developed a combine process coupling two step an aerobic digestion for the production of biogas and digested. And this two step and aerobic digestion is also producing in addition to biogas indigested, VFA, volatile fatty acids residues. And these volatile fatty acids residue is used for the PHA production.

And this here you can see the pilot plant that we have developed in Verona in Italy. This is the Innoven companies. This has been also financed by the company, but also of course, in the framework of the bigger project, which is a European project and this, by coupling this production of PHA with biogas and digest and indigested, it means that we are able to increase the added value of all the agricultural residues and also to facilitate the development of such type of process at local scale.

These PHA are mixed with lignocellulose fibers in order to decrease the economical cost, but also the environmental cost of our trays and to tailor also the bio properties, the permeability I would say of our trays, according to the type of food we are intending to pact with. And the mixtures of PHA, and lignocellulose fibers are shaped with commonly used thermal forming processes, industrial thermo forming processing. In fact, this is an injection molding, simply.

In some cases, we are using some specific additives to give some additional active and intelligent function to our materials. Here this is an example of oxygen absorbed beans, additives. We are, we have developed based on the sizing nano iron, nano clays and the additive is then dispersed within the material itself during the shaping process. And there is a very efficient absorption of oxygen and therefore an increase of the bio properties of the materials, when necessary, of course, only. Currently we have produced these materials at the, I would say pre-industrial scales in different type, in different shapes. We have tested also these packaging materials on different food with fresh fruit and vegetables. Of course, it was the easiest, but also with fresh cheese, fresh meat and also fresh poultry.

These materials have been developed in the framework on four different European projects. The first one was EcoBioCAP. He handed about five years ago. The second one is the NoAW project, which means No Agricultural Waste. In this particular European project, we have developed the coupled process with an aerobic digestion of PHA production with an aerobic digestion. We have also made some scientific and technical advances in the [inaudible 00:14:59] BIS Project, which was not coordinated by, in Robert, by the university of Rome. And here we have made some advances in order to use other residues than agricultural residues for the production of this material. And especially by using you burn residues, both for the as effluent for the PHA production, but also for the production of lignocellulosic fibers. And we are also currently going on developing this material, especially by having some intelligent and active function in the framework of the GLOPACK project, which is also a European project.

And these, all these materials have been developed using multi-scale approach, whether it's free main scale, which are used. The first one is the material engineering scale, where we are studying the material itself at the different scale, molecular, nano, micro and macro. The second scale is dealing with mainly with the food packaging system, they are mainly including process engineering modeling, which means then here we are considering the packaging with the food itself and how this packaging is able to answer the requirement of the food in term of bio properties active, for example, anti-microbial properties and so on. And the third scale is the scale of the stakeholders themselves where we are taking to account the industries, requirements to the consumers and end user requirements, but also environmental aspect. Then here we are developing what we call knowledge engineering modeling.

And all this scale are couple. This is an example of what we have developed a multi-scale structure mass transfer prediction system, where we are developing modified, and most fair packaging, according to the different type of packaging extra. Assimilation of modified atmosphere packaging with the food itself, and then a multi criteria queering able to when associated to packaging that the base to be able to rank packaging solution, according to the requirement of the different stakeholders, which means that you will say, for example, I want to material with this permeability of oxygen, this permeability of water, vapor permeability but I want a cost lower than X Euro by kilogram. I want a transparent or not transparent and so on.

And currently we are using this tool, this decision support tool for equal designing our materials. And we are also working on translating all the output of this decision support system into more comprehensive environmental impact. And this is an example of environmental score, global score we have developed. That is taking into account the raw material origin, the food losses reduction. So, it's efficiency, and it's necessity to reduce food loss. And the third parameters is about the material end of life. And for each parameter, there is a score, which is indicated according, for example, if the material is renewable, not renewable from competing with food and so on and et cetera. Okay. And that's all, thank you for your attention.