ECLIPSE FINAL REPORT

Collaborative Project (FP7-NMP-2011.2.3-1)

Project No: 280786

Project Acronym: ECLIPSE

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1. Final publishable summary report

1.1 Executive summary

Not only society but also Governments are highly concerned about the environmental issues, and hence there is an increasing interest in the development of alternative sources for chemicals, plastics and energy. Thus, the **main objective** of ECLIPSE project, funded by the European Commission within the 7th Framework Programme, was to develop novel waste derived packaging concepts unrelated to fossil fuels and to the food chain by the revalorization of biomass waste materials for the production of PLA matrix and different nanofillers extracted from banana plants and crustaceans shell wastes.

In the ECLIPSE project, it was addressed the above issues by the research and development of i) novel 100% biodiesel-algal-waste based poly (lactic acid), ii) 100% waste-based bionanofillers from residual waste from banana plantations, and shells of shrimp and crab from the seafood industry, and iii) tailored inorganic fillers from over-abundant sources. Main achievements of the project are summarized bellow:

At the novel ***100% biodiesel-algal-waste based poly (lactic acid),*** work was based on:

- The research on the best microalgae strain based on their biochemical composition.
- The evaluation of the best cultivation procedures for industrial scaling-up.
- The research on carbohydrates extraction, enzymatic fermentation process and PLA polymerization and the scaling up of all the processes.
- At the ***100% waste-based bionanofillers*** from biomass waste from banana plantations, and shells of shrimp and crab from the seafood industry, work is based on:
- The isolation of cellulose pulp from banana wastes and chitin from crustaceans shells.
- The production of cellulose and chitin nanofillers by three different approaches i) chemical, ii) mechanical and iii) using ionic liquids.
- The functionalization/modification of cellulose and chitin nanobiofillers.

At the ***tailored inorganic fillers*** from over-abundant sources, work is based on the functionalization of:

- Inorganic silicates for gas barrier properties.
- Metallic oxide nanoparticles for light-barrier properties.
- Inorganic microfillers for thermal stability and cost reduction.

To put the cap on this intensive research effort on materials, novel dispersion technologies have been developed to provide a successful move of the materials towards industrialization, with a high focus on liquid feeding extrusion mechanisms in the presence of compatibilizing and plasticizing agents, to provide top performing masterbatches and compounds.

ECLIPSE project has reached to an end once these materials and processes to reach real industrial application. To ease developed technologies reach the serialized state, two end-users (one multinational and one SME) has introduced the project materials and processing technologies into targeted applications:

- **Agricultural bags**, being this the flagship product of BANACOL's plastic factory.
- **Flexible pouches for moist soft wipes and cleaning clothe**s, as a multilayered product with high requirements from BIOPAC.

Finally, it has successfully obtained different PLA based bioplastics for the two target applications. In addition of being 100% biobased, the materials used in the manufacture of these products, are compostable, which is an incentive for the commercial exploitation of these results.

In addition of these results, dissemination activities included a workshop, conferences and journal papers, a newsletter and press releases, and a dedicated project website: http://www.eclipseproject.eu.

1.2 Description of project context and main objectives

At current consumption levels, known recoverable crude oil reserves will dry up in approximately 30 years. Therefore, it is essential to plan these technical and economic upheavals by **replacing crude oil-sourced polymers and fuels with truly renewable ones**. Efforts to shift from **oil-based to biomass-based** plastics such as **poly(lactic acid)** (PLA) are increasing as companies look ***for ways to protect the environment and create sustainable societies.***

Poly(lactic acid) is a compostable polymer derived from renewable edible sources (corn and sugar beet) and has **the highest potential** for a commercial major scale production of renewable packaging materials. However, a report by the European Commission published in December 2010[i] highlights the concerns of **land grown crops based biofuels and bioplastics** as they increase the amount of land devoted to agriculture worldwide and **increase the price of agricultural products like corn, wheat, fats and oils**. In contrast, algae are not edible and currently represent a very promising area of research right now as researchers are now looking out to the sea for **future polymer and fuel feedstocks**.

ECLIPSE aimed at decreasing the **production cost of both PLA** and **algae-derived biodiesel** by increasing the added value of algae biodiesel biomass waste via its revalorization into producing lactic acid.

The objective of **ECLIPSE** was to develop novel waste derived packaging concepts **unrelated to fossil fuels** and to **the food chain**. The ECLIPSE approach intended to revalorize **waste materials** for the production of not only **the PLA** matrix but also to reinforce the PLA matrix with **non-edible** functionalized waste nanofillers extracted from **banana plants, almond shells and crustacean shell wastes** (see Figure 1).

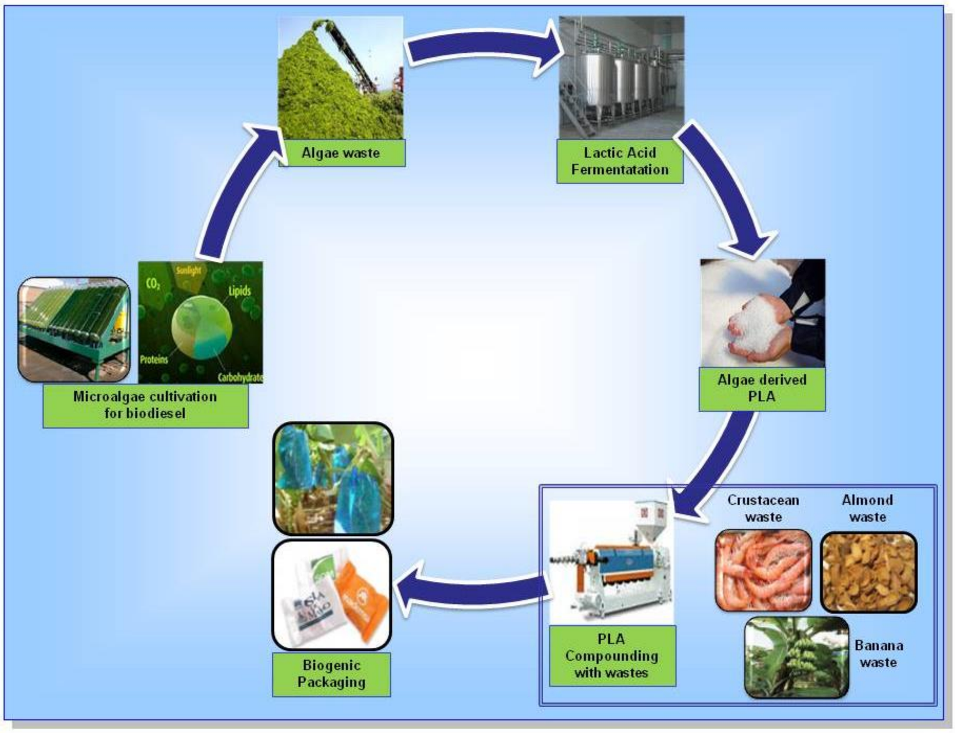

Figure 1. ECLIPSE approach to waste-derived novel PLA packaging products.

Today **packaging accounts for 70%** of the PLA market. For some of the more demanding film-packaging applications, the **brittleness of PLA** and its **poor thermal resistance and limited gas barrier properties** have prevented its complete access to such applications. It is expected that the performance improvement to be developed during the ECLIPSE project will allow the use of PLA in two key markets: the **household sachet** and the **agricultural bags markets**.

The main goals of ECLIPSE are captured in the following particular **scientific and technical objectives** to be achieved in the project:

- Extraction and purification of lactic acid from the waste of algae biodiesel biomass production.
- Development of new biogenic PLA grade derived from lactic acid from algae waste.
- Extraction, purification and functionalization of polysaccharide nanofillers **from natural waste materials**:
  - Cellulose nanofillers from **banana plant** and **almond shell** wastes.
  - Chitin nanofibres from **crustacean shells** wastes.
- Functionalization of inorganic fillers to impart good compatibility with PLA:
  - Organically modified nanoclays (Montmorillonites, sepiolite, halloysite) for improved gas barrier properties and thermal resistance.
  - Inorganic nano TiO_2, ZnO for light-barrier properties.

- Conventional microfillers (calcium sulphate, talc and others) to **decrease cost**.

- Development and validation of **novel dispersion methods for nanofillers** in liquid media prior to compounding and during extrusion compounding in the presence of compatibilizing agents, to **maximise dispersion** of nanofillers in PLA.
- Complete structural and physico-chemical characterization of the new PLA nanobiocomposite films.
- Improvement of PLA film properties to match those of 12 µ **polyethylene terephthalate** (PET) films currently used in **household sachets** multilayer structures:
  - Oxygen transmission rate from 800 to 200 cc/m2/24 h (ASTM D-3985).
  - Water vapor transmission rate from 380 to 50 g/m2/24 h (ASTM D-3985).
  - Film heat shrinkage from 10% to 2.5% (ASTM D1204, 150 ºC 30 min).
  - Ultraviolet light absorption (less than 3% transmission below 320 nm).
- Improvement of the properties of PLA films to match those of polyethylene films currently used **for agricultural bags:**
  - Elongation at break from 17% to 190% (ASTM D-882).
  - Impact resistance from 0.03 J to 2.3 J (ASTM D3420-94).
- **Life Cycle Analysis** (production, use, disposal/recycling) including **cost analysis** of new PLA-based packaging.

Household sachets

Plastic household sachets for dry and liquid consumer goods are very popular as they allow the production and sale of very convenient **single portions.** However, they present a significant waste problem and therefore the utilization of a renewable compostable polymer such as PLA for the fabrication of sachets is highly desirable. These sachets are made up of multilayer structures composed of at least two layers: an outer **high gloss** reverse printed **12 µ PET layer** and an inner linear low density polyethylene (LLDPE) layer of 40 to 100 microns that allows heat sealing of the sachet and provides certain barrier to water vapor. For more sensitive products (those requiring higher barriers to water vapor and oxygen or light protection) a middle layer of vapor metalized bi-axially oriented polypropylene (vmBOPP) is also included in the sachet structure (see

Figure **2**).

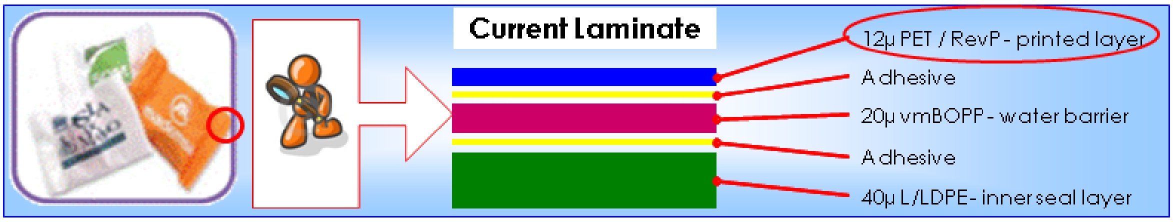

Figure 2. Household sachet multilayer structure (outer PET layer to be replaced by PLA).

PLA is highly transparent and can be easily printed which makes it suitable for this application. However the **light, gas barrier and thermal properties of PLA** are far inferior from those of PET and therefore need to be improved during the course of ECLIPSE to match those of PET.

The final PLA-containing sachet multilayer structure, i.e. the number of layers and thicknesses of the layers will be dependent not only on the final barrier and mechanical properties achieved by ECLIPSE but also on **the type of product that it will contain** (more sensitive products require better barrier).

Agricultural bag

The agriculture industry uses millions of kilograms of polyolefins each year to produce **plastic films and bags to cover plants and fruits.** BANACOL, one of the most important multinational corporations in the production and commercialization of agro-industrial products, is particularly interested in a cost competitive renewable and compostable material to cover fruits during their growth. This will replace the actual oil-based **non compostable polyolefin bags**.

PLA, although compostable, is **very brittle** and cannot be easily transformed into plastic bags **unless plasticized** and reinforced to improve its impact resistance and elongation at break. It is the purpose of ECLIPSE to provide the agricultural market with a PLA-based sustainable and renewable plastic bag solution.

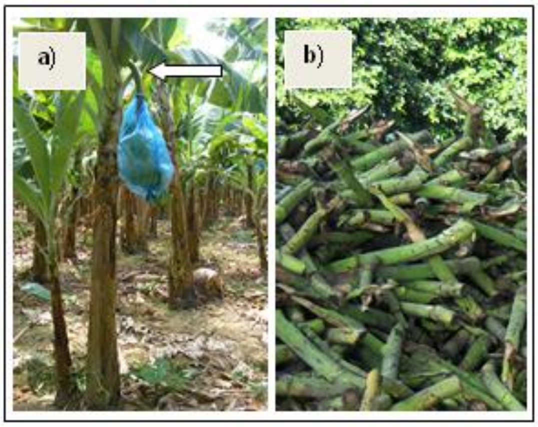

Figure 3.a) Banana plant rachis pointed b) Harvested rachis.

The ECLIPSE strategy to achieve these novel biogenic packaging concepts consists of a step-wise approach that integrates the work, expertise and facilities of all different partners. The industrial partnership has been designed to combine leading companies to supply the raw materials ALGAENERGY (algae), GALACTIC (lactic acid), FUTERRO (PLA), BANACOL (banana waste) and ANTARTIC (crustaceans waste) with sound research groups that are active on biopolymers, nanoparticles functionalization and dispersion (UMONS, CIDETEC, FRAUNHOFER, LTU, UPV/EHU, UPB, PUC) as well as a global end user BIOPAC with multiple converting facilities for plastic packaging.

1.3 Description of the main S&T results/foregrounds

The project has been highly active and successful since its inception in April 2012.

Main activities, scientific and technical results and foreground generated are summarised in the paragraphs below.

Selection and cultivation of dual purpose algae

Overall, the algal biomass comprises three main components – carbohydrates, proteins and lipids. Depending on the particular strain and the growing conditions, algae show large differences in the percentages of these key macroconstituents: typically 25-40% of protein, 5-30% of carbohydrate and 10- 30% of lipids/oils, by dry weight.

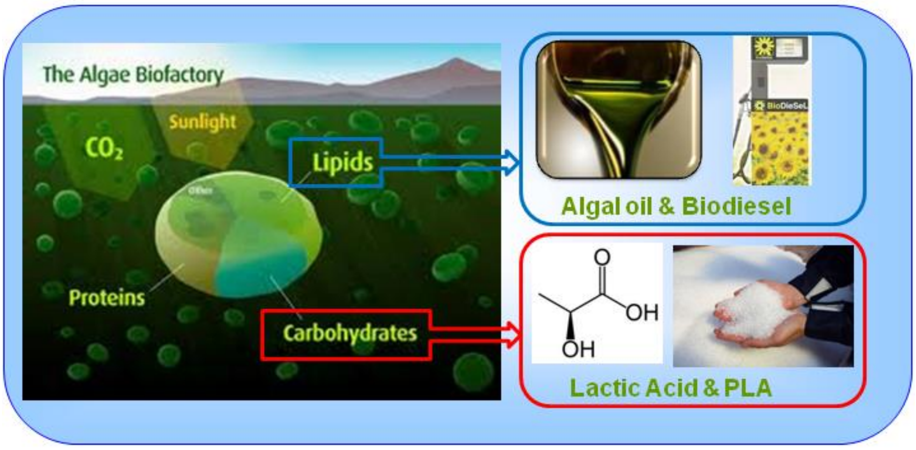

Figure 4. The double purpose algae approach for biodiesel and lactic acid production.

The lipid fraction of the biomass can be used to produce **biodiesel** whereas the carbohydrates can be fermented to produce a biopolymer feed stock **such as lactic acid** as shown in Figure 4. Algae are the optimal non-edible source for second generation based PLA due to the fact that they are high in carbohydrates fermentable into LA.

ECLIPSE project **optimized the strain selection and cultivation conditions** in order to develop novel strains with good yields of both lactic acid and biodiesel. These novel strains contain carbohydrates easily fermentable into LA, such as high amylase and low amylopectin starches as well as cellulose free of hemi-cellulose.

For verifying the feasibility of the whole process 1 Kg of the selected alga waste from lipid extraction was used for obtaining lactic acid with positive results. The selected microalga was chosen based on the combination of different factors: accurate proportion between carbohydrates and lipids and fast growing rate at lab scale. However, this microalga was specifically cultivated for the project, since nowadays, despite of being technically feasible, the production of biodiesel from algae is not yet economically viable (See D2.7, section 4 Economic and Viability Study).

The **difficulties found during this activity** were related with the growing up of algae for the scaling up process. The criterion for the selection of the algae strain was the high content of this specific alga of fermentable sugars together with the high content of lipids. This selection was carried out at the beginning of the project and the selected alga seemed to be the perfect candidate at lab scale. However, when the scale up of the process was addressed, the performance of this strain during winter time came to light, being lower than expected. **For solving this problem**, two additional varieties of algae were studied in order to achieve the growing rate needed for the industrialization of the process. Specifically, one of the additional varieties had a very fast growing rate and high amounts of biomass could be achieved in a short term. However, none of these strains shown the concentration of fermentable sugars needed for the obtaining of lactic acid (page 17 of the attached pdf " Core Periodic Report"). For the scaling up process 104 Kg of wet biomass of selected alga strain was produced for the obtaining of lactic acid.

Lactic acid from de-oiled algae biomass carbohydrate waste

Algae cake that is left over after extraction of oil for biodiesel (primarily composed of carbohydrates and proteins) can be converted into LA through fermentation of the sugars. This gives rise to the **interesting possibility of producing both biodiesel and LA from the same algae**.

The chemical composition (lipid, starch and carbohydrate ratios) of microalgae greatly depends not only on the strain selected but also on the growing conditions utilized.

During the project, lactic acid batches have been successfully obtained for their further polymerization into PLA (Figure 5).

Figure 5. Lactic acid from purified and impurified lactic acid.

Regarding the performance of the process studied at lab scale, the yield of each involved step results in a global yield in experimental conditions of 10% of the weight of dry matter that can be converted to lactic acid. These steps include hydrolysis, fermentation and purification:

- Hydrolysis yield (w/w): 17% of the alga weight can be converted to sugar.
- Fermentation Yield = 94%
- Purification : 62-65%

Thus, the global yield in experimental conditions, taking into account the different steps can be calculated as follow:

(0,17 X 0,94 X 0,635) X 100 = 10% of the weight of dry matter can be converted to lactic acid

As the raw material (wet alga) contains 20% of dry matter, it can be concluded that approximately 2% (w/w) of the wet material can be converted to lactic acid, that is to say, 100kg of wet alga provides 2kg of lactic acid (See D.2.6).

Regarding the PLA production, it is a multi-step process consisting on the following steps: oligomerization, cyclization, purification and polymerization.

For each step, the yield and the quality of the product were analyzed comparing with lactic acid from sugar beet.

- Oligomerization step is not LA purity dependent for the yield but for the quality (higher racemization & colour).
- Cyclization is dependent of LA purity for the yield and the quality (higher racemization & colour).
- Purification is LA purity dependent for the yield but not for the quality.
- Polymerization is not LA purity dependent for the yield and slightly for the quality (as purification allows reaching lactide polymer grade).

At the scale of work (lab scale), the global yield of PLA obtaining process was very low. In industrial conditions, the losses of materials involved in each step will be minimized due to the possibility of reusing and recycling of by-products.

Within ECLIPSE different samples of PLA from algae in powder form were produced (Figure 6).

Figure 6. PLA from algae.

After thermal, physical and mechanical analysis it can be concluded that both types of PLA, sugar beet PLA and algae derived PLA are equivalents. Both types of polymers show no significant differences in thermal behaviour, in terms of stability and thermal parameters such as Tg and Tm.

Functional inorganic fillers (FIF) to improve PLA performance

the specific functionalization of natural inorganic nano/microfillers such as nanoclays and metallic oxide nanoparticles, e.g. nanoTiO_2 and nanoZnO that are either commercially available or purposely-synthesized in the framework of the ECLIPSE project, were used to compatibilize and to facilitate the dispersion in PLA endowing targeted properties to the resulting nanocomposites. These functionalized nano/microfillers will be incorporated into PLA to improve the properties of PLA and fulfill the application requirements of agricultural bags and household sachets.

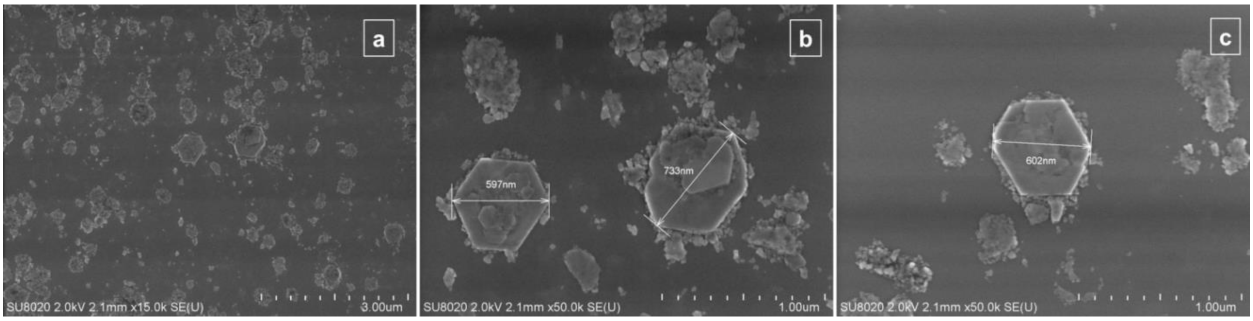

Figure 7. SEM micrographs of ZnAl LDH at different magnifications.

<u>Polysaccharide based nanofillers (PSN) to improve PLA performance</u>

Plant based wastes were used as a source of cellulose nanofillers and the crustacean ones to isolate chitin nanofillers which can be useful for many applications. Their use for packaging applications in combination with biomass-based polymers as matrices, allows **achieving a completely sustainable closed loop**, as plants and sea animal wastes would be used for high-standing developments in this sector.

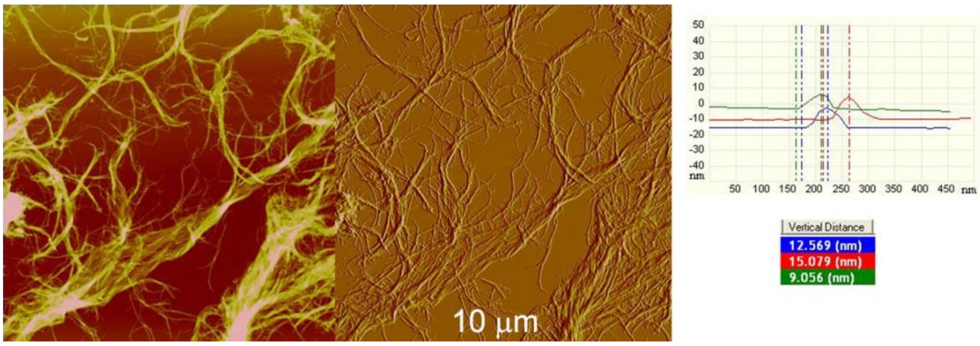

Figure 8. Height and amplitude AFM images of the banana nanofibers and the measured fibers dimensions

<u>Scalability of materials and processes</u>

With respect to the final requirements for agricultural bags and flexible pouches, specified formulations for each application had to be investigated, especially the requirements for the production of agricultural bags. The material needed to be strong but also flexible, with high melt strength for stable processing on a blown film line.

Figure 9. Blown film with cellulose nanofibre composition.

During the project, specific formulations adapted for the final applications were developed and the amounts of materials needed for validation trials were manufactured.

Validation of materials in the final application

The validation of the selected products, wipe pouches and agricultural bags, included the manufacturing process at the facilities of the end users and the material properties achievement. Both products were successfully manufactured and materials were validated with specific tests.

- ***Wipe pouches sachets***

  In the case of wipe pouches, the manufacturing process was especially complicated when the co-lamination of different layers (with different composition) was carried out. To overcome these difficulties, for the preparation of the second generation of validation materials, the same base material (PLA) was used in each layer, obtaining a good quality film.

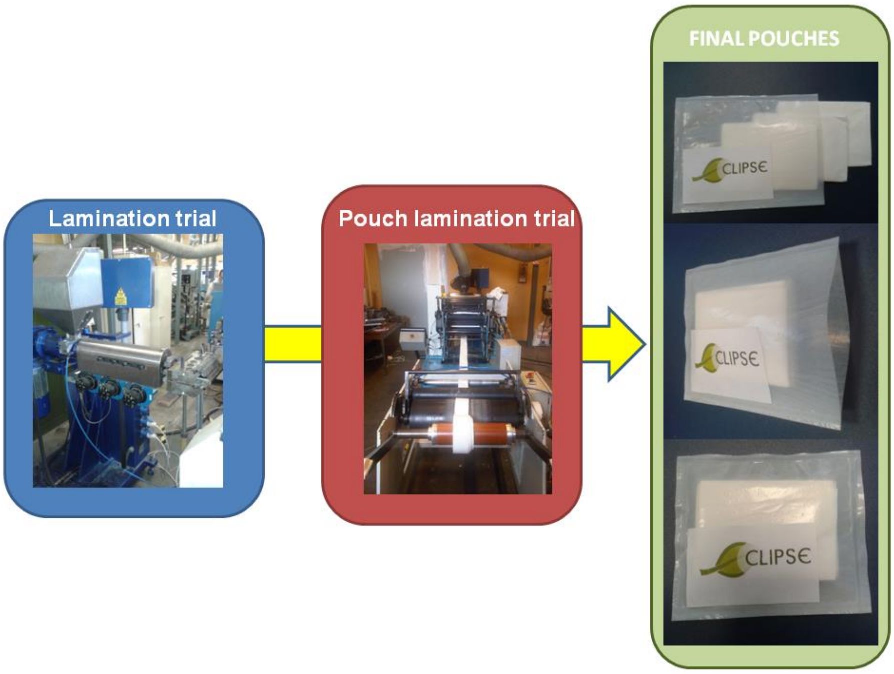

Figure10. Scheme of wipe pouches manufacturing with ECLIPSE materials.

In terms of properties, the most restrictive for the final use of the product was the gas barrier properties. It has to be taken into account that in the objectives mentioned in the DoW (part B) the reference material was neat PLA, while during the project PLA has been modified with different additives in order to achieve a material that fulfils the requirements of the application in terms of processability, flexibility, etc. This deviation was already considered in the evaluation of the project's risks and the production of a multilayer film was proposed as a contingency plan (See Section 1.3.3 Risk management and associated contingency plans, WP5: "Developed PLA based nanobiocomposites do not achieve targeted barrier properties"). In fact, the colamination with a SiOx coated PLA allowed the achievement of the targeted barrier properties (tables 1 and 2).

Table 1. Reference values for ECLIPSE materials.

PROPERTY	TEST METHOD	20 mm PLA FILM	PET 12 mm layer
WVRT	ASTM D-3985	380 g/m^2/24 h	50 g/m^2/24 h
OTR	ASTM D-3985	800 cc/m^2/24h	200 cc/m^2/24h

Table 1. Gas barrier properties of ECLIPSE materials.

SAMPLE NUMBER	MATERIAL	OTR ($cc/m^2/24h$)	WVTR ($g / m^2 /day$)	Thickness (microns)
2	FIF 4.2 FILM	231	135	83.0±1.9
6	FIF 4.2 FILM/SiOx coated film	75	38	73.0±1.7
10	FIF 4.3 FILM	484	108	42.3±2.0
11	FIF 4.4 FILM	465	109	43.0±1.0
12	***FIF 4.4 FILM/SiOx coated film***	51	27	63.5±1.7

- **Agricultural bags**

  This was the most challenging application, since the current material used for agricultural bags is PE and the machinery is adapted to this material. There was necessary a huge effort to adapt the process to the novel material based on PLA.

  Because bags producing process was adjusted to a very different material, PE, the setting up of the parameters was not obvious. In fact, the first generation of materials developed within the project was not suitable for blow moulding process at industrial scale (even if at lab scale was possible to produce bags) and the adjustment of the compounds was carried out for the second generation. For that reason, the obtaining of agricultural bags was considered a success by itself.

  Additionally, there was another challenge linked to the validation due to the amounts of materials involved in the manufacturing process. On one hand, for the setting up of the machine parameters around 200-300 Kg of compound was needed (100 Kg/hour).

Bioflex with green color and UV additives

Figure 11. Blow molding of ECLIPSE materials for agricultural bags.

On the other hand, regarding properties, the compostability was one of the most significant properties for the validation of the project materials. It was planned to test the compostability after field trials, but due to the fact that 12 weeks were necessary to the growing of the bananas, there was not enough time during the project life to carry out these tests. However, compostability was tested at lab scale verifying that ECLIPSE formulation was compostable.

Finally, it must be said that ECLIPSE agricultural bags were not able to resist the severe weather conditions in Colombia and the strong wind damaged prematurely the bags. It was suggested that a thicker bag will allow the use of ECLIPSE materials for this application and the influence of the thickness in the resistance of the material was investigated at lab scale with positive results. Unfortunately, there was not time during the project life to prepare the amounts of materials needed to carry out a new manufacturing of agricultural bags at end user facilities.

Validation is widely described in D6.1, D6.2 and 6.3 as well as in the Core Periodic Report, page 58 to 81.

LCA and cost analysis

PLA has been proven to be an environmental friendly bio-based raw material. When PLA is used for the production of films additives are needed. These additives often go along with a poor environmental performance. Therefore, accompanying research is required that focuses on the environmental performance of these additives. The development of bio-based softeners can also support the overall performance, also leading to reduced environmental impacts in the end-of-life stage. It needs to be analyzed whether nanomaterials also have the potential to contribute to a better performance.

Regarding costs, it can be summarized that final products are more expensive than current products used in each application. However, the benefits derived from the use of fully renewable and compostable materials can be an incentive for the commercial exploitation of these results.

1.4 Conclusions and recommendations

Although most of the objectives were achieved, some of them were very challenging and some recommendations for future projects should be proposed. Main conclusions and recommendations are described below:

- **Dual purpose algae** strains have been investigated for both lipids for biodiesel production and carbohydrates for lactic acid extraction. It has been demonstrated the technical feasibility of the process and a complete cycle has been carried out with the selected alga strain. This strain showed a high content in lipids and carbohydrates and a suitable growing rate. For the industrialization of the process, it should be necessary a deeper study on algae strain performance taking into account not only the lipids and carbohydrates content but also the growing rate *along the different seasons*.

  Regarding the availability of raw material, nowadays there is not an industrial waste from algae used for biodiesel production due to the fact that currently it is not a competitive product comparing with fuel base diesel. In the future, if there is an industrial production of biobased fuel from algae, the whole valorization of the algae (not only for biodiesel and lactic acid, but also for pigments, antioxidants and other additives obtaining) will allow that the process becomes profitable. As the results gathered during this project showed that we can reasonably expect to extract 17 % of fermentable sugar from the selected algae, the one that turned to be best candidate, the maximum affordable price for the algae wastes becomes 0,04 € per kg of dry matter.

- The **obtaining of lactic acid** from carbohydrates of algae was achieved. The limiting step was the maximum content of carbohydrates that can be converted to fermentable sugars and that it was around 17% refered to the residual biomass after lipids extraction. Other steps involved such as fermentation and purification have rates at lab scale that can be high enough for an industrial process (94% for fermentation and 62-64% for purification process).

- **PLA polymerization process** from lactic acid obtained from algae was successfully achieved. At the scale of work in the project (lab scale) the global yield of PLA polymerization process was very low. In industrial conditions, the losses of materials involved in each step will be minimized due to the possibility of reusing and recycling of by-products. One of the most critical processes in PLA polymerization is the purification step, where the loss of material is a 35% for each stage. With the low amount of PLA obtained it was not possible to validate the product in a demonstrator. However it was demonstrated that PLA from algae was the same that commercial PLA from sugar beet in terms of thermal and mechanical properties, that is to say, once lactic acid is converted into PLA there was no differences in the final material due to the source of raw material used.

- **Extraction of cellulose and chitin** from biomass waste. Regarding cellulose, mechanical methods (combined with chemical treatments) have shown to be a scalable and cost effective methods comparing with ionic liquid extraction. Functionalization was successfully carried out in all cases and PLA nanocomposites were obtained by casting. However it was not a suitable modification for the preparation of nanocomposites by melt blending. To overcome this drawback a scalable method for the incorporation of PSN to PLA was addressed in the compounding.

  Concerning chitin, an innovative method for obtaining chitin flour from crustacean shell is under evaluation for intellectual property protection. Additionally, other significant results obtained were the development of an easy method for tuning the dispersability of chitin nanocrystals in different solvents.

  From an industrial point of view, the most challenging task was the preparation of 500 g of chitin nanocrystals supplied for the first trial of validation and additional 60 g for the second trial. Further investigation for the industrialization of the process should be necessary.

- **Inorganic filler functionalization** was also achieved at the scale needed for validation. The most significant results were the improvement of the properties of the nanocomposites due to the incorporation of functionalized nanofillers and two scientific papers were prepared with these results. Some of the methods used for the functionalization can be used at industrial level.

- **Regarding compounding**, a scalable method for the incorporation of chitin and cellulose nanofillers was used in the preparation of masterbatch. Additionally, during the project the formulations suitable for each application were developed at lab scale. These formulations were scaled up and a ffirst generation of both types of compounds (for agricultural bags and for wipe pouches) were developed. These formulations were not suitable for the final applications in terms of processability. For that reason, improved formulations in both cases had to be developed and second generations of compounds with adapted properties for the targeted applications were used for validation trials. It should be useful for future projects to develop “base” compounds at industrial level in parallel with lab scale trials, in order to prevent possible deviations derived from the scale of work.

- **Validation activities** included the manufacturing of the final products at the end user facilities and the evaluation of the properties. In both cases, manufacturing was successfully carried out, despite of, in the case of agricultural bags, two different trials for being able to produce bags were necessary. In terms of properties, the main difficulties were found in the barrier properties achievement for wipe pouches sachets, and it was necessary the colamination with a SiOx coated PLA film. In the case of agricultural bags, the main difficulty was the weather conditions that damaged the bags. It was demonstrated at lab scale that the increase of the thickness could avoid these problems. Thus, in the future, it should be necessary an adjustment of the final formulations in order to fulfil all the requirements necessary for bananas cultivation.

The project has demonstrated that it is possible to obtain PLA from algae waste and to modify it by compounding with polysaccharides based nanofillers from renewable resources in order to obtain two different end products: agricultural bags and sachets for wipe pouches. In addition of being 100% renewable these products are compostable.

Contact details for the project and partners

Several details about the project can be found on the project web site:

http://www.eclipseproject.eu/consortiumpartnership

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[i]European Commission. Report COM(2010) 811 final from the Commission of 22 December 2010 on indirect land-use change related to biofuels and bioliquids.