entomo
agroindustrial

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1. IDEA

The ethical and legal imperative to maintain the environment in adequate conditions, guaranteeing sustainable development, has favored the emergence in recent years of new technologies related to the use of organic waste.

The current model of consumption and social economy implies that the generation of waste by a growing population is, in consonance, increasing.

This implies the need to implement strategic and planning measures to reduce the volume of waste produced by different anthropogenic activities and that, to a greater or lesser extent, generate environmental damage.

Thus, the tendency in recent years has been to improve waste management, reducing discharge, controlled and uncontrolled, as well as sources of pollutant recovery (particularly incineration) to use waste as a resource, through other sources of recovery or methods such as composting.

Since 2013, the breeding of insects has aroused great interest in Europe, due to the urgent need to find new sources of high quality animal protein. The use of insects as a source of food. It contains many environmental and health benefits, insects have a high degree of conversion from a wide variety of sources of organic matter; its production implies a lower production of greenhouse gases, produce high quality proteins; its environmental impact is less; it requires less space, etc.

These insects can feed on organic matter and produce high quality products such as proteins (for use in feed and food), fats (detergents, industrial oils), chitin (water purification, agriculture, chemical and pharmaceutical industries) or substrates capable of fertilization. They are used with great interest, to reduce the volume of waste, significantly reduce transport costs and generate value-added products.

This process has given insects an immense innovative potential to reconnect the different spheres of the agri-food industry and the food chain. This new industry that begins to emerge also has the potential to connect with other industrial areas related to the generation of waste.

This new industry is generating great expectations. As explained above, the demands for high quality animal protein are very high all over the world. Currently, the commercial platform of Entomo AgroIndustrial is working and offers its services. However, we have carried out the technical and economic studies that confirm that at this moment an adequate investment would accelerate the success and benefits of the platform and, thanks to it, its growth.

2. PRODUCTIVE MODEL

The model is based on the industrial application of Hermetia illucens (black soldier fly) as a converter of organic matter. This species has been selected for its high conversion capacity, for being an efficient converter of a great variety of waste of different kinds, for allowing its industrial production at very high densities, and for not being considered a pest or an insect that could have an impact negative in the environment.

Given the great variety of raw materials that can be used as growth substrate for the black soldier fly and taking into account the legislative particularities, we have established two areas: valorization and reduction.

3. COMPANY BACKGROUND

Entomo Consulting S.L. is a recently created technology-based Murcian company, which has a multidisciplinary team of highly qualified young entrepreneurs from the academic and research environment of the Regional System of Science, Technology and Enterprise (SRCTE), and specializes in the biotransformation of byproducts of the food industry, using insects as bioconverters.

4. RESEARCH CENTER

The Pilot Plant is a very flexible structure that will allow us to carry out the validations required to create technology transfer models for our customers, as well as to experiment with new technologies that optimize our systems and generate new production systems. With the following objectives:

- Start immediately a production of BSF that allows us to adapt and domesticate BSF to our industrial conditions.
- Validation and reduction of waste: the plant could validate different types of products and their mixtures from many different suppliers. This would greatly improve the calculations with respect to factory returns. It would also improve the relationships we have started with the suppliers of raw materials.
- Showcase function: it would be the first plant in Spain of this type, which would show the technology to the governmental authorities that need to understand this type of industry, our suppliers of raw material, potential clients or investors.
- Realization of investigations: rapid experiments would be carried out to optimize processes, develop new products and test some of our ideas in a short time. These investigations would allow us to participate in congresses, publication of papers, and in general create and maintain a scientific image that supports technology transfers.

Our short-term production goals are:

- Validation of waste for the projects that we have in progress
- Experimentation with various residues
- Optimization of the productive system

The initial objectives for the investigation are:

- Typology and extraction of fats
- Development of hydrolysates
- Generation of products from toxic substrates
- Use in biodigestion
- Preprocessing of substrates to facilitate digestion
- Second generation reactors

The methods to make this plant profitable in the short term would be the following:

- Validation services for different types of waste
- Technology transfers
- Research projects
- Aid for innovation from regional, national and European governments
- Subsidies for the creation of new companies

5. APPLICATION PRODUCTION PROCESS

5.1. VALUATION OF RESIDUE

In the valorization of the waste, the objective is the generation of diverse products with added value, starting from waste, and using insects as biofactories.

Among the residues that we have already valued to a greater or lesser extent, are those coming from the hotel trade, vegetable waste from horticultural crops, fruits from strio of horticultural or fruit crops, by-products of the viticulture industry (yeast skins and sediments), of the brewing industry (bagasse and sediments of yeast), residues obtained in the production of cane sugar, molasses or beets, wastes from the industralization of olive oil or oils from seeds, etc.

In this valuation model, a waste, or a group of them, are previously characterized and either separately, or by designing a balanced mix of all of them, they are arranged in the production system. An established amount of larvae is available on this food, which in a cycle of only 12 days are able to increase its mass by 50 times.

This larval mass is subsequently processed to obtain products with added value:

- Fresh or dried larvae that can be marketed as an additive in pet food.
- Flour with a protein content of 37-43% and a fat content of 32-36%, for use in animal feed.
- Defatted flour with a protein percentage of 51-63% and a fat content of 3-6%, for use in animal feed.
- Fat for use in animal feed.
- Compost, which results from the digestion of the waste by the insect.
- Hydrolyzed larva, which would involve the sale of pure protein for inclusion in animal feed or for human consumption, regardless of the type of waste used.
- Other products that we are currently investigating through a national CIEN project: peptides with antibiotic capacity, chitosan, bio-active products, etc.

Currently the legislation allows the inclusion of this type of flours in animal feed, for pets and aquaculture, and for human consumption (previous registration), provided that residues are used mostly of plant origin. It is expected that by 2020 its inclusion in feed for monogastric animals will be allowed. The advantages of including this type of flours in animal feed have already been scientifically described.

The competitive advantage of this model is clear: we start from a waste with little value, and we obtain a battery of products with added value in a biological cycle of only 12 days, without producing contaminants or unwanted by-products.

5.2. WASTE REDUCTION

In the waste volume reduction model, the approximation is similar to the valuation model, but underlining that the objective is the reduction of the waste taking advantage of the insect's conversion capacity, and not the generation of products with high added value.

In this model we would select waste as manure from livestock (with special interest in poultry manure), slurry, sludge from WWTP, digestates, etc. This waste poses a continuous problem not only for the producers of this waste, but also for the managers that must collect and process them.

In this process, after the characterization of the waste, these would be introduced into the system (mixed or not with other waste), and a certain amount of larvae would be established on the waste. In this case, the larval cycle would lengthen to about 20-27 days, since the nutritive content of these feeding substrates is much lower, and the obtained larval mass will also be lower.

Waste reduction is centered around two criteria and objectives.

1. Volume reduction: 60-70%
2. Reduction of pathogenic microbial load: ex. $10^9 - 10^2$ *

**Depends on the initial load and desired end. Final objective depends on whether it will give you further treatment.*

Both objectives must be quantified and validated, since they depend on the specific mix of waste, how standard it is and its previous and subsequent handling. For example, the total time lapse of time (storage, transport, temperature, etc.) before being all mixed and the application of the larvae can have an effect on the pH, and this in turn the quantity and effectiveness of the larvae.

The technical advantage of using larvae of the species Hermetia illucens is that by making 'ideal' mixtures of different residues, mixtures can be processed that could not be treated in another way or at very high costs.

The competitive advantage of this treatment method is that variants can be developed for each mixture according to the needs of each specific geographical region; or legislative requirements. It opens a market that has not yet been attended to and explored

6. RAW MATERIALS

We indicate the main products that we obtain from insects and how they are processed. After the fattening process of the larvae (section 5.2.4), the obtained substrate, which contains compost with the detritus of the insects, and the larval biomass, passes to an automatic screening system that separates the compost from the larval biomass .

- The **compost** is a stabilized biofertilizer with a humidity of less than 25%, which can be used directly for organic amendments in crops. Its immunostimulant activity has been demonstrated on crops, also providing a NPK 3:1:3.

- **Larval biomass** is not a product of the process we use to extract several high-interest products.

The larval biomass is automatically transferred to our rendering system, which consists of the following steps:

1. The available larval biomass is automatically introduced into a 150-liter autoclave for sterilization and crushing. The equipment is a biohazard sterilizer, which works with saturated steam as a sterilizing agent, and has a temperature range of up to 137 ° C and pressure of up to 2.7 bar (40 psi). The machine is designed as a large steam medical sterilizer according to the EN285 standard, designed to operate continuously.

2. The equipment performs both crushing and steam sterilization in a single pressure vessel. The vessel is equipped with a motorized shaft, with powerful crushing / crushing blades that can rotate in two directions. Crushing is important as it improves steam penetration therefore improves the result of the sterilization process. At the end of the process, the material becomes a thick aqueous solution, free of bacteria, viruses and prions.

3. The obtained "soup" is transferred to a stainless steel tank, called equilibrium tank, and manufactured in stainless steel 316L (food grade), in accordance with the Pressure Equipment Directive (PED).

4. From the equilibrium tank, the resulting soup is passed through a pump to a decanter, where the solids will separate from the liquids. The decanter is a centrifuge for the rapid immersion of solids. The centrifuge is driven by a cylindrical drum, partially conical, that rotates rapidly, and inside it is an Archimedes screw, which rotates at a speed different from that of the drum (differential speed), so it "screws" the solids on the walls of the drum.

5. Then, continuously, the solid part is sent to a 1.5 Kw dryer, which dries the paste obtained at a temperature of 60 ° C, going from an initial humidity of 40-50%, to a final humidity of 5% . In continuous mode, the dryer is emptied and its contents packaged directly. The obtained flour, which can be hydrolyzed, can contain more than 65% protein.

6. The oil obtained from the separator can be stored directly in tanks at the end of the process, or be treated in a subsequent process for the separation of certain fatty acids. The process water, which is completely cleaned and disinfected, can be used again in the autoclaving and crushing system.

7. CURRENT PROJECTS

7.1. VALORAGRIN

"Valorization of food industry byproducts through the production of insect meal"

PARTNERS: 5 AGRO INDUSTRIES + 2 RESEARCH CENTERS
DURATION: 3 YEARS
AREA: REGIONAL
CALL: RIS3MUR
TOTAL BUDGET: € 1MILL.

The general objective of the project is the evaluation of a new process of transformation of by-products and agrifood residues that allows its valorization through the production of insect meal (the insect meal will be used to make tests in aquaculture) or its high byproducts. Value added (protein concentrates, hydrolyzed protein, fat extracts, purified fat, chitin and organic fertilizers), the fertilizer will be used for field testing. Therefore, it is an industrial research project with planned and critical studies aimed at acquiring new knowledge and skills that will be useful to develop an innovative activity in an emerging market, such as industrial insect breeding.

7.2. BIOPRO

"Obtaining bioactive components for the agribusiness sector through bioconversion processes of animal and vegetable byproducts"

PARTNERS: 8 AGRO INDUSTRIES + 4 RESEARCH CENTER
DURATION: 4 YEARS
AREA: NATIONAL
CALL: CIEN
TOTAL BUDGET: € 6MILL.

BIOPRO is a collaborative project to obtain a new process within the bioeconomy: a platform that integrates for the first time stages of bioconversion (through insects) with biorefinery to obtain extracts of interest, with both nutritional and technological functionalities, and its incorporation into new products for human and animal food.

7.3. VALUEWASTE

"Integrated urban waste valorization systems to obtain key strategic products for the European Union"

PARTNERS:

9 AGRO INDUSTRIES

3 RESEARCH CENTERS

DURATION: 4 YEARS

AREA: EUROPE CE-SFS-25-2018: Integrated system innovation in valorising urban biowaste

CALL: H2020

TOTAL BUDGET: € 10MILL.

COUNTRIES: SPAIN | FINLAND | DENMARK | BELGIUM | FRANCE | SWEDEN

The 19 partners participating in this proposal will work together to develop an innovative concept to use waste as a raw material for the production and recovery of critical compounds needed for Europe. The Consortium is made up of a wide range of organizations, including 7 small and medium-sized enterprises (SMEs), 3 research and technological organizations, 1 university, 1 standardization body, 2 European municipalities and a large group of partners, including 2 large companies , an industrial group, a group of companies and a business association.

The implementation of the project is organized in 12 work packages with a total duration of 48 months.

We are aware that this is a risky and ready-to-use approach, but we have the perfect team to implement our initiative and develop the first complete solution to fully value the biological waste that can be replicated throughout Europe.

WEBSITE: www.valuewaste.eu

7.4. NEW PROJECTS

With the aim of expanding the innovation tasks developed in the research center, Entomo Agroindustrial participates in numerous research consortiums that are waiting for a resolution to receive European funding.

RUSTICUS

Objective

Strategy for the implementation of circular bioeconomy business models in rural communities.

Partners

9 Industries
10 Research Centers
3 Public Administrations

Duration. 48 months
Area. Europe
Call. H2020
Budget. €10,3 mill.
Budget € 510.000 (70%)

I AM PRO+

Objective

I AM PRO + focuses on three different alternative sources of proteins, ie, insects, microalgae and microorganisms, and will develop food and feed applications based on these alternative proteins.

Partners

7 Industries
6 Research Centers

Duration. 48 months
Area. Europe
Call. H2020
Budget. €9,4 mill.
Budget € 530.000 (70% subvención)

FLYCYCLE India

Objective

The main objective of the proposal is to build a system capable of treating various organic waste produced in cities and valorize waste in industrial raw materials.

Partners

1 Industry
1 Research Center

Duration. 24 months
Area. India
Call. Bilateral Projects
Budget. -
Budget -

FLYCYCLE Colombia

Objective

The main objective of the proposal is to build a system capable of treating various organic waste produced in cities and valorize waste in industrial raw materials.

Partners

1 Industry
1 Research Centers

Duration. 24 months
Area. Colombia
Call. Bilateral Projects
Budget. -
Budget -

8. FACTORY

During the industrial process, we have 4 main areas, linked one to the orther. The investment will vary depending on the volume of waste treated per day.

1.COLONY FACILITY

In this facility, the population of insects necessary to generate the larvae, required for the treatment of the by-product, is maintained. It covers all the instars of development of the insect (egg, larval stages, pupa and adult), in a cycle of about 40 days, in which 95% of the neonate larvae generated are dedicated to the treatment of plant by-products, and the rest to the maintenance of the population. It requires a more precise control of the temperature and humidity conditions (30 °C, 75 %), to guarantee an exact calibre of the larvae that are generated during the process. This center finally generates the larvae of 5-7 days necessary for the treatment of the by-products. In the proposed scenario, about xxxx m2 would be needed for the reception of goods, breeding rooms, laboratory, handling, etc.

Accessory to the "Colony Facility" is the "**Diet**" area, a raw materials reception area (for the preparation of the specific diet for the maintenance population), diet preparation room, breeding rooms, warehouse, laboratory, and restrooms and changing rooms.

2.DIET FACILITY

The organic waste reception area offers the possibility to collect (at full capacity) xxxxxx tons of waste per day. It will be organized in xxxxx m2, with access for means of transport, ramp for unloading trucks, organic collection tank.

Once in the tank, the waste will be mixed and crushed using an endless hopper, until it becomes a homogeneous format and a consistency similar to a purée. The raw material comes daily from different suppliers. Depending on the nature of each raw material, it must be processed, cooked and preserved. Crushers, stoves, conveyors and pumps will be used depending on the final mix.

Storage Pumping: A complex mixing and pumping system will be available to prepare the final mixture and place it in the incubation or fattening area.

3. FATTENING FACILITY

In the fattening centre, neonate larvae (5-7 days old) and by-products to be treated daily are received. In the fattening centre the insects develop for 12-15 days, depending on the characteristics of the by-product used, at a temperature of 30 °C and 65% humidity. The feed for the fattening process can be available only once, at the beginning of the process, or daily throughout the fattening cycle, depending on the type of by-product used. At the end of the fattening process, some xxxxx tonnes of biostabilised compost suitable for use in agriculture has been generated, and some xxxxx tonnes of larval biomass for transformation into products. All this is automatically collected and separated prior to the product generation process, into the **Separation Room**. It also has a **Storage Room**, and **bathrooms** and changing rooms for staff.

4. TRANSFORMATION FACILITY

The Transformation Facility receives the xxxxx tonnes of larval biomass generated during the fattening process, free of impurities, which is transferred directly to the rendering process to obtain various products. This facility requires about xxxxx square meters, including ancillary facilities, warehouses and shipping area. The approximate steps to obtain the products are:

1. The available larval biomass is automatically introduced into an autoclave for sterilisation and crushing. The equipment is a biohazard sterilizer, which operates with saturated steam as a sterilizing agent. The machine is designed as a large medical steam sterilizer in accordance with EN285, designed for continuous operation.
2. The equipment performs both crushing and steam sterilization in a single pressure vessel. The vessel is equipped with a motorized shaft, with powerful shredding/shredding blades that can rotate in two directions. Crushing is important as it improves steam penetration thus improving the outcome of the sterilization process. At the end of the process, the material becomes a thick aqueous solution, free of bacteria, viruses and prions.
3. The "soup" obtained is transferred to a stainless steel tank, called an equilibrium tank, made of 316L stainless steel (food grade), according to the Pressure Equipment Directive (PED).
4. After this process we extract the chitin contained in the larval biomass.

5. From the equilibrium tank, the resulting soup is passed through a pump to a decanter, where the solids are separated from the liquids. The decanter is a centrifuge for rapid immersion of solids. The centrifuge is driven by a cylindrical drum, partially conical, which rotates quickly, and inside is an Archimedes screw, which rotates at a different speed from that of the drum (differential speed), so it "screws" the solids into the walls of the drum.

6. The liquids (oil and water) will be transferred to a Separator, and the "cake" (solids) will be transferred to a Dryer.

7. Then, continuously, the solid part is sent to a 1.5 Kw dryer, which dries the paste obtained at a temperature of 60 °C, going from an initial humidity of 40-50 %, to a final humidity of 5%. In continuous mode, the dryer is emptied and its contents packed directly. The flour obtained, which can be hydrolysed, can contain more than 65% protein.

8. The oil obtained from the separator can be stored directly in tanks at the end of the process, or treated in a later process for the separation of certain fatty acids. The process water, which is totally clean and disinfected, can be used again in the autoclaving and crushing system, or in the production, cleaning or maintenance processes of the factory.

9. INVESTMENT EXAMPLE

ANNUAL CAPACITY (TON / year)	**109,500.00**
CAPEX	8,389,311.40 €
OPEX	2,341,171.96 €
INCOMES	21,146,475.58 €
EBIDTA	15,510,117.52 €
Civil works	4,800 m^2
Production (Ton)	**33,243**
Frass/Compost	17,346
Hydrolyzed protein	3,061
Chitin	1,020
Lauric acid	1,184
Other fats	429
Larval Biomass	10,203
Sale Prices	
Frass/compost (€/Ton)	51
Hydrolyzed protein (€/Ton)	1,144
Chitin (€/Ton)	12,485
Lauric acid (€/Ton)	2,913
Other Fats (€/Ton)	468
Larvae (€/Ton)	0

10.LICENSING MODEL

The Licensor is the owner of the Know-How for the industrial production of black soldier fly and the Patent.

The Licensor grants the Licensee an exclusive and non-transferable license to use the Confidential Information and Production Procedures for the production of black soldier fly and the obtaining of the raw materials derived from the larva of black soldier fly: protein, fat, chitin and fertilizer .

Neither the Confidential Information nor the Production Procedures will be used for any other purpose than the one specified, in case the Licensee is interested in the production and sale within different territories, the corresponding license will be obtained from the Licensor.

The Licensor will develop and provide the Licensee with an "Engineering Project" for the establishment and operation of a factory for the industrial production of black soldier fly and obtaining derivative compounds.

The licensee will use the information and documents contained in the Project with the sole purpose of building, designing and starting the factory, this information is considered confidential.

The Licensee may not grant sub-licenses, without prior and express written consent of the Licensor, this duty must remain in force after the termination of the contract. The Licensor undertakes to provide the Licensee with the necessary Technical Assistance to produce black soldier fly and obtain the raw materials of interest and to implement the Center under the terms and conditions described in this Contract.

The Licensor is willing to license the use of the Know-How and the Pending Patent both of the aforementioned processes, as well as to provide Technical Consulting Services specifically in relation to this agreement.

The Licensee is interested in the production of black soldier fly and the distribution and sale of the products obtained and wishes to obtain from the Licensor the license to use the Know-How, as well as the Technical Consulting Services.

The Licensor is willing to license the use of Know-How and the Pending Patent of both processes mentioned above, as well as to provide Technical Consulting Services specifically in relation to this agreement.

The Licensee is interested in the production of black soldier fly and in the sale of derivative products and wishes to obtain from the Licensor the license to use the Know-How, the Pending Patent as well as the Technical Consulting Services in the terms and conditions They remember.

By the license of the Know-How and the patent of the industrial production process of black soldier fly and the services described in this licensee undertakes to pay the Licensor the following fees:

- Quarterly income for the canon of exploitation of industrial and intellectual property rights.
- Revenue from maintenance consultancy of the production process
- income from the marketing and exploitation of the final product
- Revenue per license to use the software of the production process

Royalties will be paid quarterly, in euros, by bank transfer to the account provided by the Licensor. Licensee will submit a written notification confirming that the payment agreement has been made.

In the event that the Licensee does not pay the amounts owed and payable to the Licensor within forty-five (45) days from the expiration date, the Licensor shall have the right to terminate this Agreement.

The Licensor shall have the right to audit all records related to the production of the plant, the sales and any other document or material that is under the custody and control of the Licensee and that is necessary for the verification of the Royalties owed to the Licensor. The requested information will be kept strictly confidential.

The technology license will have a duration of 5 years, expandable in case of agreement, this communication must always be made in writing and with acknowledgment of receipt, either party will have the obligation to communicate about the continuity or not of the contract 2 months before of the expiration of the Contract.

11. AWARDS AND HONOURS

11.1. 7th Edition Generation Award

The Generation Awards promote innovative projects that add value to society and the economy in Spain. Based on innovation and entrepreneurship, this initiative recognizes not only the creation of entrepreneurial economic models, but also the innovative work that natural persons carry out in public and private organizations, as well as innovative projects in the social and educational field.

Organized by:

Deloitte | COTEC Foundation | Royal Academy of Engineering

11.2. Entrepreneur of the Month Award

The Entrepreneur of the Month Award granted by the Institute for Development and corresponding to the fourth quarter of last year recognize the commitment to technological innovation, the development of new services and communication channels or the promotion of the circular economy of the Hardest Clothing projects, the Newsell project and Entomo Agroindustrial.

Organized by: INFO Murcia

11.3. Entrepreneur of the Year Award

Entomo Agroindustrial wins the 'Entrepreneur of the Year Info- CLH Award' for its innovation and growth potential.

The Entomo Agroindustrial company has won the first prize of the 'Entrepreneur of the Year Info-CLH' award for its capacity for innovation and growth potential. The firm is dedicated to the use of Black Soldier Fly as a converter of organic matter for the production of enriched flours for animals. The winner has received today the award, endowed with 6,000 €, from the Minister of Employment, Enterprise, Universities and Environment, Javier Celdrán.

Organized by:
INFO – CLH

11.4. Innovative SME Seal

The Ministry of Science, Innovation and Universities, through its General Directorate for Research, Development and Innovation, has awarded our company with the SME Innovative seal.

Granted by:
Ministry of Science Innovation and Universities

11.5. AJE Region of Murcia Award

The Association of Young Entrepreneurs of the Region of Murcia (AJE) has convened, with the support and sponsorship of Bankia, the XX edition of the 'Bankia Young Entrepreneur of the Year award. Heroes 2019 'to look for the best entrepreneurs in the Region of Murcia.

The 'Young Entrepreneur of the Year Award' and the 'Best startup award' will be the main awards in this edition, which will also be awarded an 'Honorable Mention to the Business Trajectory' of a leading businessman in the Region of Murcia and, as a novelty, a 'Mention to Institutional Support to Entrepreneurship.

Organized by: AJE Region of Murcia – Bankia

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