



PROJECT

N-FOOD

PRODUCED BY FUTURA BSM C.A.

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1.- INTRODUCTION

For centuries, many cultures have practiced entomophagy. Coprolites found in caves in the Ozark Mountains in the United States indicate the presence of insect remains¹. It is estimated that, at present, more than 2 billion people consume insects in Africa, Asia, America and Australia, not only for their taste, but also for their nutritional potential and their low cost^{2,3}.

The advantages of insects over conventional protein sources are well known, but consumer acceptance in the Western world is the most important obstacle to their consumption^{4,5}. According to a study carried out in Poland, people are more willing to eat food made from insects than raw insects⁶.

Insects can be used to feed humans and animals. In 2021, the European Food Safety Agency (EFSA) approved the first edible insect for humans, the Flour Worm or *Tenebrio molitor*; And since 2017, it is legal to feed pets and aquatic animals. Since then, interest in insects has grown, as revealed by the exponential increase in academic publications on the matter⁷.

Studying the physiological and nutritional qualities of insect extracts is vital for the future. Recent research has shown that insect peptides can be used as antihypertensive, antibacterial and antioxidant agents, demonstrating their usefulness^{8,9,10}.

On the other hand, the characteristics of insect proteins make them ideal for making edible films and coatings, in order to protect or enrich food. Using supercritical fluids, lipids with functional properties can be extracted from the larvae¹¹. Also, ultrasound-assisted extraction can be performed, which is a sustainable method that achieves lower times with better efficiency and quality of the extracted compounds¹². The number of studies on the functional qualities of insects is extremely limited.

An ideal insect to be used in the production of food for animals and human consumption, is the Black Soldier Fly or *Hermetia illucens*. The nutritional composition of their larvae has average values of 37.89% Protein and 18.82% Fat, among others¹³, competing with soy or fish meal¹⁴.

By feeding the larvae of *Hermetia illucens* with different diets, its energy and nutritional composition can be modulated. Using a waste wheat fiber and whey substrate produces an extract with 40% protein¹⁵. This allows us to infer that it represents an optimal base for the elaboration of a final product destined for human consumption. Regarding the use of these larvae, for the preparation of food for human consumption, there are few documented references, but several websites can be cited that promote the consumption, sale of insects and their derivatives for the human diet^{16,17,18}.

Raising *Hermetia illucens* larvae has the additional advantage that they can be fed with organic waste, contributing to the circular economy, since millions of tons of food and agricultural products become waste. The larvae obtained can then be processed in order to make food for human consumption, and the waste biomass can be converted into organic fertilizer.



About Us

“Futura BSM C.A., is a company dedicated to Biotechnology with a focus on the insects breeding, as a means to carry out the Formulation and Production of Foods for Animal Use, Human Consumption and Bioproducts for Plantations.

We are specialist and pioneers in the design of biosystems for the cultivation of insects; our premise is continuous improvement and optimization. We develop innovative processes through which we take advantage of the potential of insects to produce food with an adequate nutritional and functional composition, providing benefits to those who consume them.

We reinsert organic waste into the food chain through insects, achieving a circular and self-sustainable economy scheme, providing solutions to simultaneously solve problems related to the environment and food safety.

We also carry out the ecological breeding of farm animals, promoting the maximum respect and well-being towards them, conserving the natural environment in which we operate, taking advantage of the resources that the soil offers to balance the diet of the animals with the products we make, developing their genetic potential in a natural way, also avoiding the use of synthetic substances and products.

Our efforts are aimed at closing the food production cycle, valuing waste streams, to bring food directly from the farm to the table”.

In this sense, we are in the development phase of a series of foods that we have called N-FOOD; The term "N" refers to the fact that they are New, Nutritious, Natural foods and at the same time that they can be elaborated in N-Number of types and presentations. The novelty of foods is that they all include insect protein as a nutritional base. In addition, we seek that the formulation is complete and contains functional compounds, which, in most cases, are present in the ingredients used. We do not use chemical preservatives, artificial flavors or colors, neither salt nor sugar is used. The result we always aim for is to obtain a totally nutritious and balanced product, which supplements the demands and requirements of the daily diet of an average person.

On this occasion, and by way of participating in the **INOVALIMENT 2021 Fair**, we present the following two products:

1.- Protein Spicy Sauce (Hot Sauce)

2.- Nutri-Cube (Nutri-Cube)



2.- IMPORTANCE OF THE PROJECT

The focus of the project is based on the fact of being able to elaborate from *Hermetia illucens* fly larvae, a food for human consumption, capable of providing a safe, nutritious and healthy alternative to consumers, with an accessible price.

The studies cited in the introduction, in addition to multiple scientific, testimonial and physical evidence, from countries such as Uganda, Kenya, Nigeria, Indonesia, Malaysia, Vietnam, Pakistan, Spain, the United States and Canada, among others; allows to establish that the bioconversion of organic waste through insects is an operation of vital importance for obtaining good quality food, capable of meeting the nutritional requirements of animals and people in regions where there are no cultural barriers or restrictions legal for their use and consumption, as is the case in the aforementioned countries.

The main objectives of the project are the following:

1.- Make a spicy sauce based on *Capsicum frutescens*, enriched with insect protein derived from *Hermetia illucens* fly larvae.

2.- Make a concentrated cube of dehydrated foods, balanced with vegetables and carbohydrates, enriched with insect protein derived from *Hermetia illucens* fly larvae.

According to the UN, in 2019, 931 million tons of food waste were generated. The highest percentage (61%) of this waste comes from households, followed by the service sector such as restaurants and hotels (26%), culminating in the commercial sector (13%). This represents 17% of total food production worldwide.

Within these figures, the amounts of waste that are generated both in agricultural production and in industrial processing must also be considered.

Taking into account that the quantities discarded are enormous, the economic, social and environmental impacts are also enormous as well as negative. It is estimated that between 8 and 10% of GHG emissions are associated with food that is not consumed and is decomposed in landfills.

Additionally, the data of people affected by hunger in 2019 are alarming; More than 690 million people suffered from hunger during that year, with this number estimated to increase due to the Covid 19 pandemic and constant population growth.

Considering that in the year 2050 the protein needs will increase due to the 9.7 billion people estimated to populate the earth, and taking as a scenario the little or no food security that exists in many developing countries, action must be immediate.

The approach to solving this problem not only raises waste reduction as an important variable in reducing associated environmental problems, but also involves their valorization from a competitive and circular economic point of view, which it has a high potential for the development of new materials and products derived from organic and agricultural waste streams.



Now, in a world in which it is necessary to conserve and use natural resources efficiently, in which it is necessary to find technological solutions that are not only feasible but also viable with respect to the Cost / Effectiveness relationship, the production of sustainable food is of great interest, as a way to satisfy the needs of the generation of food sources that provide an alternative and safe way, non-traditional proteins. Within this whole scenario, the production of insects stands as an ideal means for this.

The cultivation and rearing of larvae of the fly *Hermetia illucens*, has innumerable benefits and advantages, among them, the following can be mentioned:

Sustainable Process. It uses organic waste as food for the larvae. The process involves the efficient use of natural and energy resources, since consumption is minimal compared to traditional agricultural and animal exploitation processes. Installation and startup are inexpensive. Respect for biodiversity is contemplated; a single species is used, and it is done by reproducing the conditions of its habitat, which is why the impact towards it is low or null, and controlled. It has a high economic potential and supposes a social welfare for all the zones in which it is applied and its direct area of influence.

Resilient Process. In the future, the effects caused by climate change may affect all links in the food production and consumption chain. However, this process has great adaptability as it does not depend on traditional suppliers and supplies, being able to cushion the changes that may occur and even influence the behavior pattern of consumers, since it includes aspects of benefit for new societies in which the cultural issue of insect consumption will be transcended at some point.

Climate Smart Process. Insect farms help to minimize the Carbon Footprint on earth by using the organic waste responsible for the emission of GHGs. Additionally, the waste biomass that is generated is highly usable, since it has all the desirable characteristics to be subjected to a simple and economical composting process, obtaining an organic fertilizer that can be used as a soil improver. Aiming for organic agriculture is something desirable and possible thanks to the use and application of this type of fertilizers and the obtaining of proteins through the breeding of insects.

Flexible Process. It has a versatility that allows it to be adapted to different spaces, to use different materials and equipment, to use different sources of organic nutrients, among which only waste can be used. It can even be located in climates other than the usual ones, since temperatures can easily be brought to the right ones, either by means of greenhouse systems, lighting, ventilation or by a combination of them. Due to the latter, it has an enormous geographical relevance, being able to reach small environments, closing the circle that begins in production and ends at the consumer's table. Applying this project in areas of extreme poverty, or being able to reach them through a new, nutritious, safe and healthy product, is something that will increase the quality of life of its inhabitants.

Profitable Process. The Cost / Benefit ratio is positive. The management of organic waste or agricultural by-products can allow the creation of small and medium-sized companies that dedicate themselves to it, with the subsequent benefits related to that activity. In the same way, it will have a positive effect for small and medium-sized entrepreneurs who want to start and promote this new production scheme, which aims to be the solution to many of the future problems. The supply chain of food and insect products is something with future relevance.

It has already been commented that the star and main protagonist of our process is the **Black Soldier Fly or *Hermetia illucens***. It is an insect belonging to the order of the Diptera and is widely distributed in the tropical, subtropical and temperate regions of the American continent; It is also present in countries in Europe, Africa, Asia and Oceania.

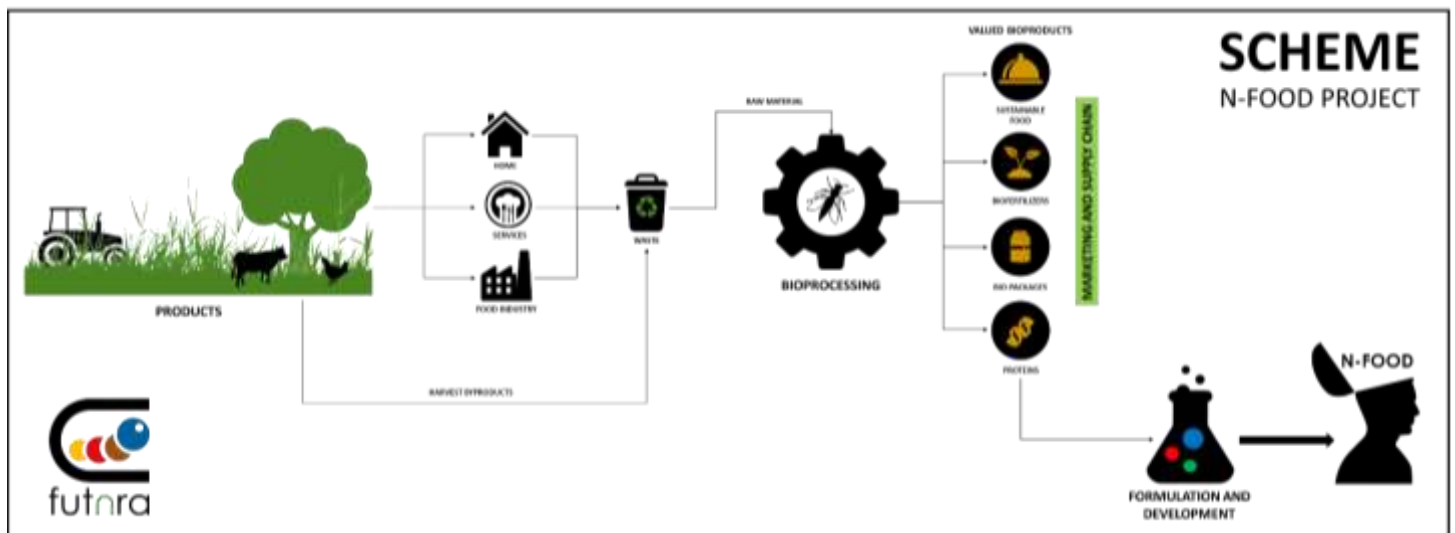
The versatility of its larvae to bioconvert various organic substrates into food and other usable products, makes it an insect that has been taking over the scientific scene in recent years.

Some of its advantages over other flies are the following:

- High reproduction rate
- Flies do not carry pathogens
- Flies do not bite or eat plants, they only hydrate
- They do not make noise when they fly
- Reduce the number of house flies
- Only larvae feed
- The larvae eat any type of organic waste
- The larvae have a rich nutritional composition
- Larval waste can be used as fertilizer

In the following figure, you can see a general outline of the project.

Figure N° 1. Scheme of the N-FOOD Project



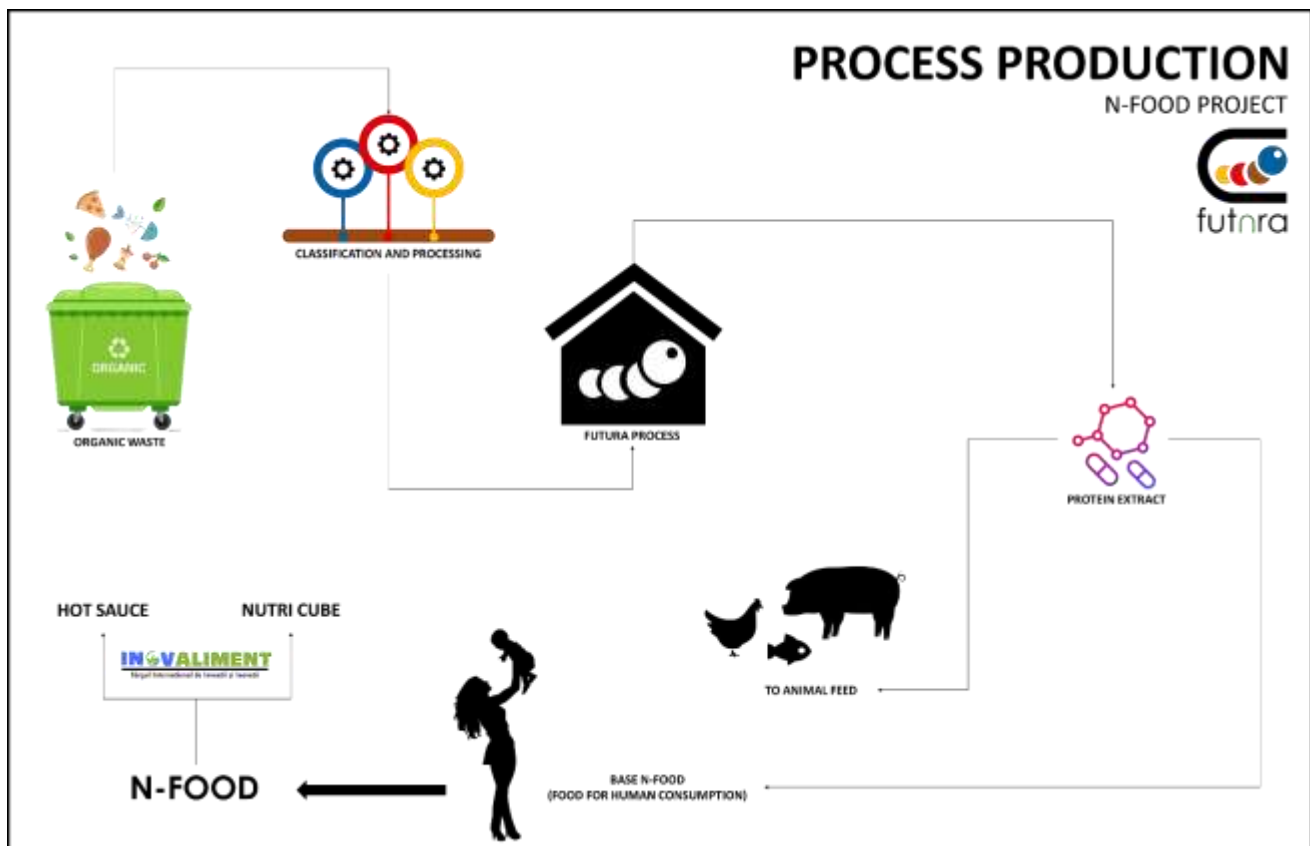
3.- METHODOLOGY AND DESCRIPTION OF THE PRODUCT

The proposed project is versatile and can be carried out under the modality of parallel works or in stages, since the stability of the raw material -in this case, the insect protein- for the preparation of food, allows it.

The implementation of the project is supported by a system composed of several specialized elements that interact together; This multidisciplinary and interdisciplinary approach, through the development of new methods and technologies, opens the doors to advance and achieve beneficial effects in various areas. The synergy inherent to the project has the effect of enhancing the results obtained.

The activities associated and necessary to achieve the objectives will be carried out as described below, but in general terms, the production process will be as shown in the following figure:

Figure N° 2. N-FOOD Production Process





In more detailed terms, the methodology for obtaining the N-FOOD will be as described below:

Activity 1: Insect Farming

The rearing of *Hermetia illucens* larvae will be carried out using a previously designed and tested biosystem. The system configuration is vertical, with movable elements that allows a more comfortable and faster execution of the associated tasks.

The brood room has a natural ventilation control system, which is activated depending on the temperature changes that occur.

Two diets are used for larval rearing; a starter diet for newly hatched larvae, and a rearing or growth diet for larvae five days old (5DOL) and up. The ingredients of both diets vary in type, quantity and proportion; But in both cases, the raw material is previously classified and selected organic waste. The waste in this particular case, comes from by-products of crops and service places, such as hotels and restaurants. After the relevant classification and selection, a formulation is made that includes other types of ingredients (but always waste), such as rice or corn bran in the case of newly hatched larvae.

The larval growth stage necessary for harvest is estimated between 14 and 16 days. After this period, the larvae are separated from the waste biomass (metabolites), which is sent to a composting process to produce organic fertilizer.

Activity 2: Preparation of Protein Extract

The larvae obtained in the previous process are first subjected to a stage of washing and removal of dirt attached to their bodies. Subsequently, they undergo a cooking process in water at a controlled temperature of 100 °C for 15 minutes, in order to achieve their sterilization and eliminate any pathogens they may contain. Then, they are sent to a drying process, which consists of dehydrating them by applying heat in an electric oven, at a controlled temperature of 80 °C for the time necessary according to the load that is being processed.

Finally, the dried and dehydrated larvae are subjected to a fine grinding process, which turns them into a powder that contains all their nutritional potential, mainly protein. This product is vacuum packed and stored at room temperature for later use.

Activity 3: Making the Hot Sauce

The hot sauce will be made with a kind of chili called *Capsicum frutescens*, a plant from warm climates, widely distributed in Central and South America.

The process begins with the classification and selection of the ripe fruits, to subsequently subject them to a surface washing process with running water, which aims to remove small adhesions and dirt present on their surface. After this, it is cooked in boiling water for 10 minutes, after which it is removed and processed together with selected vegetables, which have also been previously subjected to a separate cooking process to favor the extraction of their characteristic flavors. Finally, the powder containing the protein derived from the larvae of the fly *Hermetia illucens* is added in defined proportions. After this, a mixing and homogenization process is carried out that culminates with the vacuum packaging of the product.



Activity 4: Making the Nutri Cube

The nutritious cube is made using vegetable ingredients that provide carbohydrates, vitamins and minerals, which are selected and subjected to a controlled dehydration process.

Once dehydrated, the vegetables undergo a processing that turns them into a fine powder. This fine powder is mixed in defined quantities with the powder that contains the protein extract of the larvae of *Hermetia illucens*.

Once the mixture is made, certain amounts of natural agents are added that serve as binder, whose function is to be able to mold the product and compact it in the desired shape.

After this, it is packaged -preferably- in an edible paper made from the same protein from insects or from plant products.

The products obtained have the following characteristics:

- Salt free
- Sugar free
- Free of artificial colors
- Free of artificial flavors
- Free of chemical preservatives
- Free of “Trans” fats
- Made with natural products
- Balanced nutritional composition in proteins, fats and carbohydrates
- Contribution of micronutrients such as Vitamins and Minerals
- Adequate energy intake to supplement the requirements of an average diet
- Long shelf life and at room temperature
- Dehydration and the addition of natural ingredients give it autonomous conservative properties.
- Edible packages made from proteins, give the product the necessary protection to retain its composition intact and to minimize its decomposition or contamination due to the entry of external agents.
- Capsaicin (present in hot sauce) has analgesic, antioxidant, anti-inflammatory and anti-cancer properties.



- The protein obtained from the *Hermetia illucens* fly contains polyunsaturated fatty acids that prevent cardiovascular diseases and hyperlipidemia. It also has peptides with antimicrobial properties. It also contains Iron, Calcium, Fiber and vitamins.
- The supplementary ingredients for the preparation of the two products (Hot Sauce and Nutri-Cube) are totally natural, and provide, apart from vitamins and minerals, antioxidant properties.
- They have great gastronomic versatility and are easy to use.

In addition to the above, and in relation to the daily requirements of a healthy diet, in relation to energy and macronutrient values, the WHO recommends the following:

- Total Energy Needed 1,500 - 2,000 kcal / day in women and 2,000 - 2,500 kcal / day in men
- Protein 10 - 35% Total Energy Needed
- Carbohydrates 45 - 65% Total Energy Needed
- Lipids 20 - 35% Total Energy Needed

The fact that the processed products have been formulated to provide the maximum possible value of macronutrients to the daily diet is highlighted.

However, given their versatility, they can be modulated, reformulated and adapted to precise nutritional and energy compositions, they can be made in different presentations, and they can even be redesigned to fully satisfy the daily nutritional demand of an adult.

An example of the versatility of the Nutri Cube is that it could not be compacted and come in powder form to dress and season foods. It could also come in the form of a dehydrated soup. Another option that could be made with this product is to develop a flavor profile for the protein and coat it with chocolate, include it in snacks, in sweets for children. It could even be presented as a protein powder to prepare energy drinks. In this sense, the application horizon is promising and the market segmentation is broad.

Below is the detail of each of the products presented in this proposal, and their presentation format or prototype:




1.- SPICY SAUCE

Ingredients:

Onion / Garlic / Oregano / Salt / Vegetable Oil / Vinegar / Water / Chili (*Capsicum frutescens*) / FuturaPro (Hermetia illucens Insect Protein)

Presentation Format

SPICY SAUCE WITH BSF PROTEIN				
Type	Packaging Material	Image (Referential)	Presentation Format	Macro Nutrients (AMN/100 ml)
Liquid	Glass (Reusable)		60 ml/bottle	Total Energy 190,00 KCal Protein 20,0 g Fat 9,0 g Carbohydrates 4,00 g MICRONUTRIENTS Calcium 40 mg Phosphorus 0,2 mg
			120 ml/bottle	




2.- NUTRI CUBE

Ingredients:

Onion / Paprika / Parsley / Coriander / Celery / Garlic / Zucchini / Potato / Carrot / Turmeric / Futura Pro (Hermetia illucens Insect Protein)

Presentation Format

NUTRI CUBE WITH BSF PROTEIN				
Type	Packaging Material	Image (Referential)	Presentation Format	Macro Nutrients (AMN/100 g)
Solid	Edible Internal Packaging (Protein Film) Biodegradable External Packaging (Paperboard)		15 g/cube	Total Energy 250 KCal Protein 30 g Fat 11 g Carbohydrates 5 g MICRONUTRIENTS Calcium 100 mg Phosphorus 80 mg Magnesium 30 mg Iron 2 mg Vitamin B6 0,5 mg Vitamin C 20 mg
<i>Presentation in boxes containing 12 cubes.</i>				



Finally, some advantages of these products over others are exposed:

Adequate Nutritional Composition. Both products include vegetables and proteins with a wide range of nutritional benefits.

They promote good health and prevent disease. This is achieved thanks to the large number of compounds with functional properties used in the formulation, such as, for example, Turmeric, chili pepper (*Capsicum frutescens*) and insect protein (*Hermetia illucens*), among others.

Sustainable Food. The main base of these foods (insect protein), has been produced under an environmentally friendly process, avoiding the use of synthetic products and efficiently using the necessary natural and energy resources.

Easy to use and prepare. In both cases, the products can be used directly, they do not require prior preparation. In today's everyday life, this ease of use translates into speed, which is a substantial advantage over other products that require long cooking or preparation times.

Ecological packaging. The fact of using edible, biodegradable and reusable packaging has a high value associated with minimizing the generation of solid waste.

They can solve a problem. In the particular case of the Nutri Cube, it can be taken to places with conditions of famine and extreme poverty, to war zones, areas with natural disasters, among others. It can be included in school or popular feeding programs, especially in undeveloped countries. In the same way, it can be consumed by the most favored strata as a beneficial and healthy product.

Variety of presentation formats. Insect protein has the versatility and advantage of being able to be introduced into a wide range of products, whether they are liquid, dehydrated or even gelled.



4.- EXPECTED POTENTIAL

Until recently, not many cultures routinely consumed insects or products derived from them, especially in the Western world. However, that reality is tending to change; On January 13, 2021, EFSA declared an insect fit for human consumption for the first time. It is the Yellow Worm or Flour Worm, *Tenebrio molitor*.

Currently more than 2,000 different species of insects are consumed in the world, most of which are beetles, caterpillars, bees, wasps, ants and crickets. These figures will provoke the progressive acceptance of edible insects by the “developed” countries, which could at some point in the future be affected by the imminent changes of the planet and lose their “favored” status. In addition, many countries in Africa, Asia and Latin America have been feeding on insects for centuries, a compelling reason to demonstrate their benefits and safety.

The potential associated with the consumption of insects is enormous, and the following can be highlighted among other aspects of interest:

- Development of a series of foods with nutritional and functional properties that promote adequate nutrition and good health. Applicability in specific diets such as Atkins or Ketogenic. The extraction of nutraceutical or functional compounds can bring benefits to the health area.
- Social impact through the development of innovative methods of processing and valorization of by-products based on insects, with applicability in a wide range of fields. The change in culture and diet preferences is something that can point to new food and business schemes.
- Creation of job opportunities for established specialists, but also for young graduates attracted by the environment of research and innovation, which can result in interesting jobs.
- Versatility in the elaboration of enriched animal feed, which can guarantee and optimize the breeding process, with recognized advantages derived from the cultivation of insects and the obtaining of alternative proteins.
- Environmental benefits derived from the recovery of waste streams, minimal use of natural resources such as water, less land use, less GHG emissions. Minimal waste generation.
- Generation of direct and indirect jobs associated with the insect rearing process. Creating a cluster of companies dedicated to the integral management of the waste that is generated, and that is later used as raw material, is something possible.
- Active participation of all links in the production and supply chain, from farmers, service companies and the food industry, to product marketing and supply networks.
- Reliable access to results by SMEs interested in the development and elaboration of products, which guarantees entrepreneurial opportunities with solid knowledge bases.



- Geographical relevance due to the fact of being able to carry out the main activity (insect rearing) to obtain the raw material in a wide range of climates, between 18 °C and 40 °C, with the added benefit of being able to control temperatures that go out of range, with relatively simple and inexpensive methods.
- Solving problems associated with famine and malnutrition, by developing a low-cost, nutritious product that can reach the most remote areas of the planet since it does not merit special conservation and storage conditions. Additionally, it can be used in areas where there are refugees due to political, religious and military conflicts.
- Use of the products in school or popular feeding programs, especially in developing countries or with unfavorable conditions.
- Use of waste biomass as a potential generator of organic fertilizers and its subsequent application in soils, favoring organic agriculture, minimizing the Carbon Footprint of conventional cultivation processes.
- Economic and growth opportunity. The size of the global beneficial insects market is estimated to exceed 620 million euros by 2024.
- Unparalleled opportunities will appear in the segmentation market in the coming years, which is why it is necessary to act now with a view to the near future.



5.- LIMITATIONS

The limitations inherent in the human consumption of insects or products derived from them are basically related to two aspects, cultural and technical.

Cultural Aspects. Food is perhaps one of the aspects of human behavior that is most affected by the cultural aspect. Within the acceptable and logical limits of toxicity or digestibility, it can be ensured that, with greater or lesser nutritional capacity, almost everything is edible.

Entomophagy and entomophobia explain the acceptance and rejection of the consumption of insects by certain social groups. What may be an element of someone's regular diet in Indonesia may appear disgusting to someone in France, for example.

There are prohibitive elements, like religion; It is enough to highlight the case of pork consumption in Islam, and compare it with the consumption of pork in Spain.

Culinary customs also have a significant weight; For a Mexican or an Indian, it is normal to give a child some spicy dish, while the same would not be done in the United Kingdom, for example.

Although many people tend to think that only primitive peoples include insects in their diets, the reality is different. The same as a person with entomophobia can think, a person who practices entomophagy can think when seeing them consume marine invertebrates, snails, urchins and barnacles, ingredients that become part of luxury dishes in the high societies of the West.

Anthropological studies have concluded that the radical difference that separated both groups (entomophagous and entomophobic) is directly related to the benefit that food had for those who consumed it. In all cases, the foods consumed (insects or not) were the object of an instinctive selection that determined the best option for consumers. All this process took place in a harmonious way between man and the nature in which he lived.

In the current era, the choice can be explained through aspects related to nutrition and health, ecology and even the economy, forming part of a more logical and rational process, which in the same way carries associated benefits.

Finally, consumers will lean towards those foods that are accessible, that contain an associated benefit and that exist in abundance or at least that they are available. In this sense, in some places insects are excluded, while in other places they are integrated.



Technical Aspects. Insects are not part of the culinary tradition in Europe or the rest of the Western world, as it happens in other countries, where they are consumed regularly; FAO has been proposing for years to increase its use worldwide, both for human consumption and for animal feed.

The interest in introducing insects into the daily diet is increasing in the world, and in Europe as well. However, before that, it is necessary to assess the risks associated with the breeding and consumption of insects, and that is something that the European Food Safety Agency (EFSA) monitors.

Regulation CE 258/1997 on New Foods and New Food Ingredients, establishes that "the food safety of everything that has not been consumed in a significant and safe way as a food or ingredient in the European Union before May 15, 1997 must be evaluated. ". The authorization refers to the conditions of use, the name of the food or ingredient and the specific requirements for labeling.

Questions should be established about the safety of the process to which it is subjected, if this method has a history, as well as establishing and defining the toxicological and microbiological risks. The regulation must ensure that, if a new food is authorized, it does not pose a risk to the consumer, does not mislead and does not imply disadvantages from a nutritional point of view.

When a country receives an application, it must carry out an initial evaluation and send it to the European Commission and the other Member States for them to re-evaluate the suitability or not of the food. If there are no objections, the authorization is approved. Instead, if it considers that further evaluations are necessary, the application is sent to the Standing Committee on the Food Chain and Animal Health, which helps the European Commission to develop measures on food. This will decide whether, to authorize a certain food, it is necessary to adopt specific conditions of use and labeling requirements (composition, presence of raw materials or nutritional value).

Insects are still considered in Europe a new food from a bureaucratic point of view and the way to introduce them into the human and animal diet is long; However, the future that lies ahead is promising to achieve this, and it is based on this that we are working.



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