PROJECT

feedME - Nutritional Water

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1.- INTRODUCTION

Water is the main component of our body and represents around 70% of the total body weight in adults, and must be obtained directly or through the consumption of different foods and drinks as part of our diet. Water is an essential nutrient that performs important functions in our body, from the cellular transport of nutrients, the elimination of waste products, the regulation of temperature, respiration and blood circulation, the lubrication of structural support tissues, to intervention in synthesis and enzymatic reactions, among others[1]. In this context, hydration through water plays a fundamental role in health and well-being, which has been highly recognized in recent years among experts in the health community such as nutritionists, dieticians, general practitioners, pharmacists, educators, as well as by experts in physical activity and sport sciences and the general population. When our body lacks this liquid, it cannot perform its functions properly, causing a chronic dehydration that can put our lives at risk.

In addition to the above, water provides essential minerals such as Calcium, Magnesium and Fluoride. Numerous studies clearly show that water with moderate concentrations of Ca, Mg, HCO_3 and SO_4 protects against cardiovascular diseases. Water has also been found to protect against osteoporosis, decreased cognitive function in the elderly, decreased birth weight, cancer, and diabetes mellitus[2].

Water covers 70% of the earth and it's essential for life, but it's also a powerful force for change and destruction, and could become the main cause of future wars due to its scarcity and the deterioration of the quality of freshwater sources available on the planet. Water has become one of the most debatable and precious resources of the future, which requires more cautious and conservative management and consumption. Managing the use of water in a sustainable manner should contribute positively to the objectives of sustainable development[3].

However, apart from the scarcity of water, there is perhaps a greater problem, which is poverty and which stands as the greatest cause of hunger and malnutrition in the world. Poverty has impacted almost all sectors, including the inability to produce food, increased violence and decreased life expectancy, living in unprotected and vulnerable areas, lack of medical care and even land cultivation and animal husbandry. The statistics of malnutrition in children under five years of age are alarming. In Kerala, a developed state in southern India known for its egalitarian development, one in four children is malnourished[4]. These children are trapped in the vicious cycle of poverty and malnutrition. In addition, the association between the nutritional status of mothers and children indicates the vulnerability of multiple members of poor households to being malnourished.

Faced with this reality, it is imperative to seek technical solutions, feasible and fast, capable of mitigating existing problems. Malnutrition and famine, join to the lack of access to water that affects millions of people in the world, is a problem that must be faced from multiple angles. One of them is the production of new foods, with technologies and processes that can be replicated locally by any country that considers it of interest, in order to become autonomous, without detriment to private investors who want to produce them, since the consumer target for these is global. Climate change, the Covid-19 pandemic and the war between Ukraine and Russia have combined in such a way that the effects have wreaked havoc throughout the world. Traditional food production systems must be replaced by sustainable, resilient, climate-smart production systems.

Technology and knowledge must be simplified, shared, decentralized and reach all corners of the planet to promote changes from regional and local instances with a tendency to add to achieve the global effects that reality imposes on us today. In the process of transforming food production systems, food security and food safety must be included in a special way, since without these factors we could not speak of sustainable production. Modern technology such as RFID tags and blockchain could offer potential solutions to improve food safety and sustainability[5]. This will ensure that the products are safer and consumers can access accurate information before consuming the products.

In the short term, valorization of organic waste streams and reprocessing of food will be the best way to eliminate food loss and waste in the world to maintain the food supply chain. Within this approach, the breeding and cultivation of insects is placed at the forefront of the circular economy since it is widely demonstrated that a wide variety of species, such as *Hermetia illucens, Tenebrio molitor, Acheta domesticus,* among others; they have a high capacity to degrade and bioconvert organic waste, obtaining raw material as food *per sé* or as a basis for the formulation and development of food for animal use and human consumption[6].

The consumption of insects as an alternative source of protein is considered a future trend and a viable strategy that could potentially contribute to global food security. Insect derived proteins, in addition to their total nutritional value and amino acid profile, have been shown to have a wide range of applications as peptides with antihypertensive, antimicrobial, and antioxidant properties. Recent advances in the production of insect proteins through enzymatic hydrolysis and heterologous expression have shown a promising technology for the study and exploitation of their bioactive properties[7].

In addition to the protein obtained from insects, biorefining can be used to extract from them oils with desirable and ideal characteristics to be used in different applications for the formulation of food for animal use or human consumption, as well as in other biotechnological applications. The thermal behavior, color, the presence of aromatic compounds and the acids fatty profile are desirable characteristics to be used as table oils and as food ingredients[8].

Having seen this, this study proposes the use of a protein and lipid extract obtained from the *Hermetia illucens* fly, to develop a type of water that retains its organoleptic properties (color, smell, taste), but contains a concentration sufficient protein and fat, so that when a person consumes the recommended two (2) liters of water per day, they also consume the approximate amount of protein and fat specified for an average adult, obtaining nutrition and satiety.

The extract obtained from the *Hermetia illucens* fly has protein and fat values of around 45% and 25%, respectively, which gives it high potential to be used in this and other related projects[9]. Furthermore, these values can be manipulated by defatting the extract, with which protein can be increased and fat decreased.

The properties of the obtained extract, together with the combined use of traditional extraction and purification technologies such as HPLC and solvent extraction, supercritical fluid extraction, application of surfactants and enzymatic hydrolysis, and the use of predictive computational methods, make it possible for both proteins and fats can coexist in the product that we propose in this project[10].

2.- IMPORTANCE OF THE PROJECT

Helping the most needy people is perhaps the most immediate form of solidarity that we as human beings have, it is something that is in our hands and depends on us. Starting from this premise, we have initially conceived the development of this product as a food that is not only nutritious, but also sustainable. The fact of being able to produce something that reaches places where its population live in extreme poverty, where there is a shortage of water, armed conflicts, malnutrition problems, being promoted in school and social programs, and even used in activities that require new applications and food options due to space limitations, such as aeronautical missions in which every centimeter counts. This product has a very broad target, which is not limited only to people in need, but can also be consumed by people from other social strata, can be endorsed by nutritionists, can be tested on athletes and in general can be supplied to anyone as it has not only a sustainable nutritional character, but also a safe and healthy option to hydrate.

The studies cited in the bibliographic references, beyond demonstrating that it is feasible to carry out this and other types of similar projects, reinforce the fact that human imagination is infinite and this is precisely where we must focus our attention to ensure the inputs or raw materials we need. The farming and consumption of edible insects is something totally viable and it is widely demonstrated that it is one of the most sustainable businesses that we currently have on the planet, becoming an important component of sustainable circular agriculture by closing nutrient cycles and energy, promoting food security and minimizing climate change and biodiversity loss, thus contributing to SDG[11]. On the other hand, the production of drinking water from air humidity is already a reality. Companies such as WATERGEN in Israel provide this type of solution that addresses the growing problem of water depletion in the world[12].

Having covered the previous two points, **insects and water**, we have our raw materials. The next point of interest is in the use and application of existing technology to achieve product formulation and development.

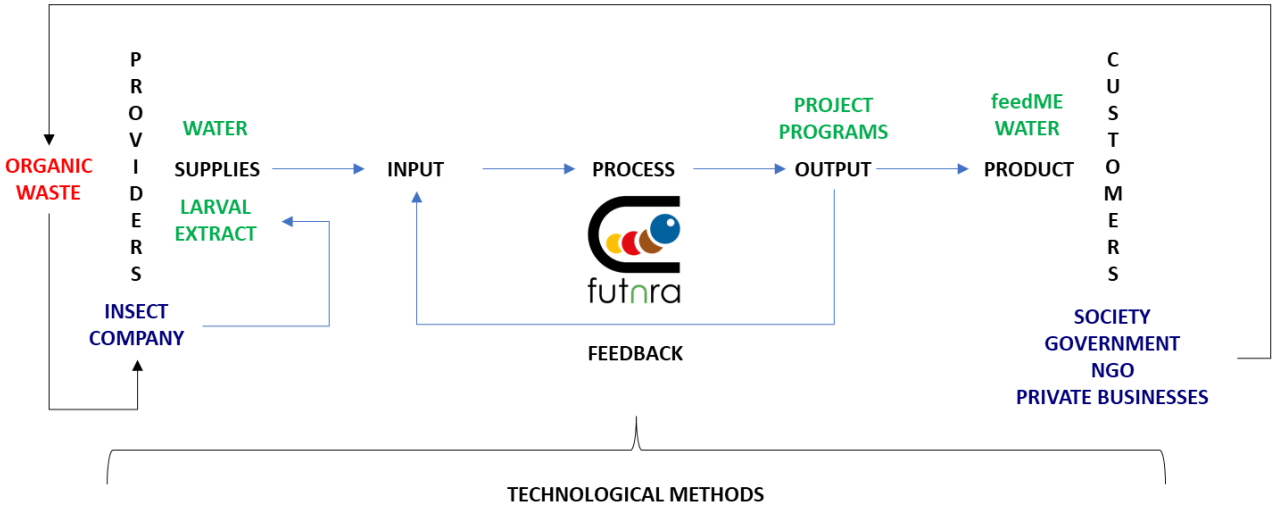
Within all this scenario, the main objective that arises is:

1.- Develop a nutritional water, enriched with proteins and fatty acids obtained from larvae of the Black Soldier Fly *(Hermetia illucens)*.

The framing of this project in the Inovaliment 2022 categories was a challenge, since it could easily be framed within any of them. It includes biotechnological aspects insofar as an insect and a biosystem are used for its production and cultivation, obtaining and processing its derivatives; it includes aspects related to food safety from the point of view of the safety of the ingredients and from the point of view of the production of nutritional water *per sé*. It could also be included in the category of innovative ingredients and although insect protein is not innovative, the fact of enriching water with it is, since most of the commercial protein hydrolysates that are available are made from vegetable proteins and albumin. It also includes aspects of advanced technology to achieve the desired results, a nutritional water that preserves its organoleptic properties. And, finally, it also converges in the **Sustainable Food** category, which after various analysis, was the one in which we decided to register this project.

The sustainability characteristic of this product is present from the process inputs to the outputs (Figure N˚ 1). Let us remember that, according to FAO data, only in 2019, 931 million tons of food waste were generated in the world. In addition to this, the transformation of traditional systems of soybean crops and fishmeal production (as raw materials for obtaining proteins) is totally feasible, since insect farming has a smaller ecological footprint due to the scarce energy resources it uses, the use of small amounts of land and the use of organic waste streams. All these elements come together and generate benefits in the productive sectors, in the consumption sectors (society in general), in the environment and in future generations, since they will be the ones who ultimately benefit most from this type of work.

Figure N˚ 1. Sustainability - Approach Based on Processes

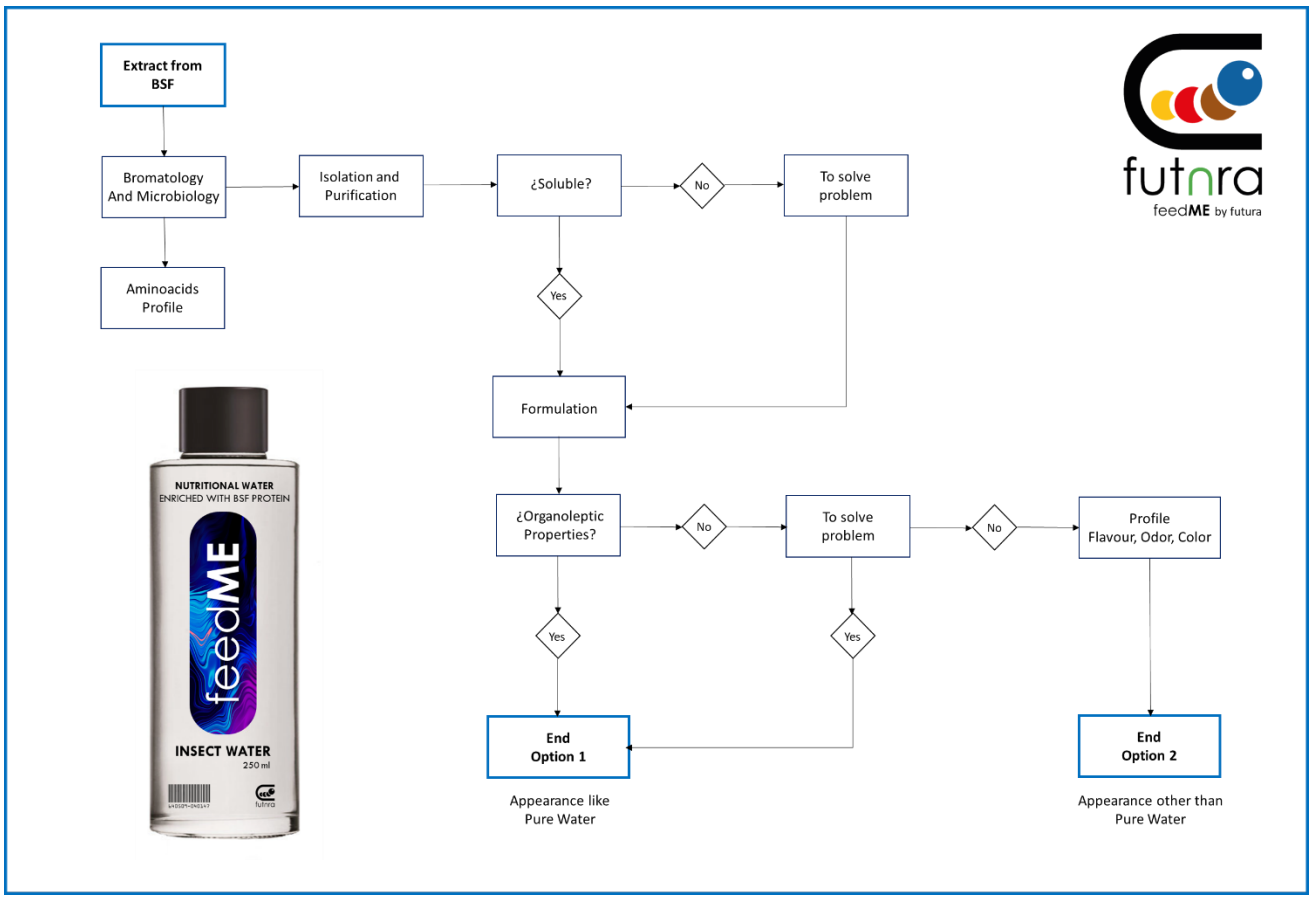


3.- METHODOLOGY AND PRODUCT DESCRIPTION

The main characteristic of this project is its multidisciplinarity, which, together with the great variety of activities that it has, make it possess a vast potential for the exploitation of various areas of knowledge and science, the development of new methods and even the change of habits in society.

In general terms, the logical sequence related to the project will be executed as illustrated in the following figure:

Figure N˚ 2. Process Flow Diagram



In slightly broader terms, the methodology for the production of feedME nutritional water will be as follows:

Activity 1: Sterilization and Dehydration of the Larval Extract

In this stage, the sterilization and dehydration of the larvae that have been reared and cultivated previously in another stage is carried out by thermal methods.

Sterilization is performed at controlled temperature and time to avoid protein denaturation. Similarly, drying or dehydration is done at a controlled time in microwaves.

In this stage, the nutritional content is ensured through bromatological analysis and food safety through microbiological analysis.

Activity 2: Defatting of the Larval Extract

Once the larval extract is sterilized and dehydrated, it is mechanically pressed at room temperature, in order to extract the oil present in it. The amount or yield of oil extraction is around 20%, with which the fat values decrease from 25% to 5% on average, while the protein value increases from 45% to 56% on average.

Activity 3: Enzymatic Hydrolysis

With the larval extract already enriched in protein and with adequate fat values, enzymatic hydrolysis is carried out to obtain medium and short amino acids chains, which are more likely to dissolve in water.

However, here the strengths of food rheology and the use of surfactants come into play, in order to be able to achieve the homogeneous incorporation of the existing fatty acids within the solution.

Activity 4: Product Formulation

Finally, the nutritional water is formulated in order to give the desired values to the product. At this stage, it may be necessary to develop a flavor profile to improve the palatability of the product.

Then, the product is packaged, an activity that can be carried out in recyclable (glass) or biodegradable (cardboard) containers, even in containers that could be edible.

The product obtained has the following characteristics:

• Contains ***Arginine, Lysine, Methionine, Phenylalanine and Threonine***, five (5) of the nine (9) essential amino acids.

• The Nutritional Content per 100 ml shows the following values: Proteins 5.6 g / Fat 0.5 g / Phosphorus 60 mg / Calcium 0.6 g

• Another characteristic is its versatility to produce by-products, since it can be used in the production of other nutritional beverages, such as fruit juices, and substantially enrich them with more than just fiber and carbohydrates that fruits contain.

Figure N˚ 3. feedME - Nutritional Water

As final advantages of this sustainable food, the following are mentioned:

Nutritional Requirements. Meets the complete daily nutritional needs of an average adult while being adequately hydrated.

Biofunctional Compounds. Protein hydrolysis provides the availability of a wide variety of peptides with antioxidant, antibiotic and antihypertensive functions, in addition to having a higher digestibility than crude protein[13].

Food Transformation. The development of this type of product drives the transition from traditional food production systems to the new production systems that reality imposes on us.

Daily Use. As its main component is water, its daily consumption does not depend on tastes and options, but is an inherent need of the human being.

Ecological Footprint. The fact of using insect protein and employing recyclable or biodegradable packaging gives the project a high degree of circularity, especially with regard to the issue of minimizing the generation of solids waste.

Global Issue Solution Option. In the particular case of the fight against hunger and humanitarian aid to people in conditions of extreme poverty, this product can be a great ally.

4.- ENVISIONED POTENTIAL

With the promotion of production activities framed in sustainability and the circular economy, as key elements to minimize their GHG emissions and stop global warming, together with the commitments that developed countries are acquiring to help the most disadvantaged countries to enter this new era of production, all in accordance with the agreements and realities that are being carried out and lived in the COP 27; the following aspects can be mentioned as strengths of the project:

• Promotion and encouragement of adequate nutrition and good health in all sectors of society, especially in the most disadvantaged.

• Use of new technologies and strengthening of research, development and innovation areas in the insect market.

• Creation of job sources and academic and professional research opportunities.

• Use of insect breeding as a didactic tool for teaching science at different educational levels.

• Use of the product in school food supplementation programs, in social or humanitarian aid programs (UNICEF, NRC, ACNUR, PHO, etc.)

• Promotion of organic agriculture and the development of new food systems and solutions based on nature.

• Investment opportunity for public and private entities, with the respective impact on the economy of the country or locality that manages to generate the product on a commercial scale.

• Use of the product in specific applications such as nutrition in space, nutrition in patients with special requirements, among others.

• It is a product that can be used in gastronomic applications and as raw material for the development of other food products.

5.- LIMITATIONS

The limitations could basically be related to the safety of the product, which is traceable and can be controlled with the traditional disinfection methods used in good food manufacturing practices; and on the other hand with the cost of the product due to the use of associated technologies to achieve the desired effect of preserving the organoleptic properties of water (smell, taste and color). However, this cost limitation would be for small-scale processing, which would not justify the investment in the use of the necessary technology. And although this happens and may be an impediment for small producers, they could choose to ignore the technology to clarify the water and preserve its properties, and opt for the development of a different drink, which, as mentioned above, could be a fruit juice enriched with protein and healthy fats.

However, for large scale product development, investment in equipment, materials and even in specific quality laboratories with modern technology is fully justified, since the return on investment would be a sure theme. Having the exclusivity of the production of a product like this ensures a high and constant source of income.

We conclude by imagining that the day will come when all the nutritional needs of the human being can be covered with a simple capsule or a glass of a drink. Food as we know it today will change a lot in the future.

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