

Brussels, 19 May 2025

COST 041/25

DECISION

Subject: Memorandum of Understanding for the implementation of the COST Action “Accelerating Innovation and Development of European Microbial Foods” (Mic2Food) CA24132

The COST Member Countries will find attached the Memorandum of Understanding for the COST Action Accelerating Innovation and Development of European Microbial Foods approved by the Committee of Senior Officials through written procedure on 19 May 2025.

MEMORANDUM OF UNDERSTANDING

For the implementation of a COST Action designated as

COST Action CA24132
ACCELERATING INNOVATION AND DEVELOPMENT OF EUROPEAN MICROBIAL FOODS
(Mic2Food)

The COST Members through the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action, referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any document amending or replacing them.

The main aim and objective of the Action is to facilitate the development of new microbial foods for the European market, by ensuring that discoveries are accelerated in a coordinated manner and translated into tangible products and by positively influencing the perception of the public and policymakers on microbial foods to allow this emerging industry to thrive in Europe. This will be achieved through the specific objectives detailed in the Technical Annex.

The present MoU enters into force on the date of the approval of the COST Action by the CSO.

OVERVIEW

Summary

With the rapid population growth, demand for food is quickly increasing and meeting protein supply requirements is becoming a global problem. Plant proteins have been proposed as alternatives to animal proteins, but their production needs big extensions of arable land and demands huge volumes of freshwater which results in considerable environmental issues. A promising solution are microbial protein for food and feed applications.

This COST action, entitled Accelerating Innovation and Development of European Microbial Foods (Mic2Food), aims to facilitate the development of new microbial foods for the European market. Mic2Food will create a unique network with a balanced geographic distribution to tackle scientific and technological challenges to make microbial food substitutes a reality. Collectively, Mic2Food aims to:

- (1) isolate and identify new, non-pathogenic microorganisms with desired properties for their application as microbial foods, including their protein content and lipid composition, and micronutrient content, and optimise their production properties in line with food regulations.
- (2) develop and upscale their production processes from lab scale over pilot scale to industrial scale.
- (3) establish downstream processing (DSP) (e.g. removal of RNA) and formulations to produce appealing products that can be commercialised.
- (4) monitor regulatory changes for microbial food and facilitate commercialisation of microbial food products in Europe and worldwide.
- (5) quantify the nutritional and mechanical properties of the microbial strains and food products in a standardised way throughout the development.
- (6) accelerate the translation from academic research to tangible products through close collaboration with established industrial partners.

<p>Areas of Expertise Relevant for the Action</p> <ul style="list-style-type: none"> ● Biological sciences: Microbiology ● Industrial biotechnology: Food microbiology ● Industrial biotechnology: Industrial bioengineering, bioreactors ● Agricultural biotechnology: Sustainable production ● Agricultural biotechnology: Biotechnology (non-medical) 	<p>Keywords</p> <ul style="list-style-type: none"> ● Microbial Food ● Biomass fermentation ● Alternative Protein ● Up-scaling ● Food Chemistry
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Specific Objectives

To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination

- Establishing of an interdisciplinary and synergetic network that accelerates the development of new microbial foods in Europe.
- Increase Europe's capacities in microbial food development by applying existing knowledge through targeted collaboration and knowledge exchange between specialised and emerging labs.
- Coordinate research efforts of the network member at a European level and create synergies for further research.
- Increase chances of commercialisation by developing a tractable road map for commercialising research

outputs via analysis of market drivers and regulatory requirements, in close consultation with industry stakeholders.

- Dissemination of research results to the general public and other stakeholders to increase the awareness and acceptance of microbial food.

Capacity Building

- Foster a closer collaboration between mentor labs and mentees.
- Increase opportunities for exchanging information and promoting collaboration throughout the network.
- Facilitate productive collaborations between industry and public research by engaging leading companies.
- Support and promote increased participation for researchers in networking activities.
- Promoting the involvement of Inclusiveness Target Countries (ITCs).
- Promoting gender balance and women's participation in leadership roles.
- Training of Young Researchers and Innovators (YRIs).
- Support visits to participating research institutions to provide training on technical or methodological aspects, with a particular focus on supporting YRIs.
- Increase collaboration and accelerate microbial food development through a stakeholder platform for the microbial food sector in Europe.
- Initiate collaboration with International Partner Countries (IPCs) to establish Mic2Food in a leading role at the international level through scientific and dissemination activities.

TECHNICAL ANNEX

1. S&T EXCELLENCE

1.1. SOUNDNESS OF THE CHALLENGE

1.1.1. DESCRIPTION OF THE STATE OF THE ART

Human ingenuity has allowed us to understand the world around us, tame the natural world, and change this planet on an unprecedented scale. Since the industrial revolution, about 250 years ago, the human population has increased 10-fold, to 8.1 billion and is expected to increase to 9.7 billion by 2050. It is undeniable, that we have left a clear mark on our world. Greenhouse gas (GHG) emissions are changing the climate, leading to devastating consequences; our need for land is directly destroying unique ecosystems, and our pollution of land, water, and air is contributing to a new mass extinction, threatening the biodiversity of our planet. Today, six of the nine planetary boundaries assessed by the Stockholm Resilience Centre have been crossed. Namely, these are climate change, biosphere integrity, land system change, freshwater change, biogeochemical flows, and novel entities.

One of the main contributors to these dramatic developments is the food sector. The food sector emits about 1/3 of the anthropogenic GHGs, of which 50% is attributed to meat and dairy production. Around 50% of the world's habitable land is already used for agriculture and the development of new farmland, largely for pasture for cattle, is a main driver of habitat loss threatening over 24000 species to extinction. Additionally, agriculture is responsible for 78% of the global ocean and freshwater eutrophication, the pollution of waterways with nutrient-rich water⁵. Especially meat and dairy products have a high carbon footprint (kg CO₂e [carbon dioxide equivalents] per 100 g of protein: beef 50, milk 9.5, tofu 2). Moreover, the excessive use of antibiotics in farming, contributing to rising antimicrobial resistance, and widespread concerns about animal welfare are significant issues associated with meat production. **It is evident that we need to revolutionise the food sector by providing alternative proteins to overcome this planetary challenge.**

Food must fulfil different needs of the human body. One of them is the **supply of macronutrients**: carbohydrates, proteins and fats. Macronutrients are needed to maintain the growth, metabolism and health of the body. Importantly, some of these macronutrients, e.g. essential amino acids (e.g. histidine, methionine, etc.) or omega-3 and omega-6 fatty acids (e.g. eicosapentaenoic acid, linoleic acid), cannot be produced by the human body and need to be taken up from food sources.

Additionally, food supplies the body with **micronutrients**: vitamins and minerals. Similar to macronutrients, many of them are not produced by the human body in sufficient amounts and need to be acquired through food, e.g. vitamins B12, D, A and K2, which are primarily found in meat, eggs, dairy, and fish. A suitable food alternative needs to fulfil these needs and supply the body with enough of all essential macro- and micronutrients. Furthermore, **to be adopted by the public, it needs to have good taste and consistency and be affordable.**

The state of the art in alternative protein

Due to the growing global population and an expanding middle class, the demand for protein has increased in recent decades. Traditional protein sources, such as livestock, dairy, and fish, have a significant environmental impact, making them a key focus for transforming the food system to achieve a rapid positive effect.

In recent years, different sustainable meat alternatives have emerged. One of these alternatives is focused on directly growing animal cells in bioreactors (**cultured meat**). However, this approach is technologically challenging resulting in high prices for consumers and until now, no company has been able to deliver production at a large scale. Because of the high energy demand for its cultivation, cultured meat still has a high environmental impact, that, depending on the energy source, can be as high as beef's. Additionally, many legislative questions remain regarding this technology.

Another approach are **plant-based alternatives**. In this approach, plant material (e.g. soy) undergoes extensive downstream processing and formulation to create a product with a meat-like texture. However, despite their advancements, most plant-based meat alternatives still lack taste and consistency, leading to a low acceptance by consumers. Additionally, their protein content is much lower compared to animal products, and they are often short in essential amino acids (e.g. methionine, leucine, lysine, and tryptophane).

An emerging alternative to these approaches is **microbial foods**. Microorganisms have evolved to colonise every place on our planet and have been used by mankind for thousands of years, e.g. to produce bread, wine, beer, and cheese. In this approach, microorganisms are grown (often in large

bioreactors) to produce a new food product. There are **three main different types of microbial food**: (1) traditional fermentation, in which food (e.g. milk or grape juice) is converted by an organism or a consortium of organisms to a new product with enhanced flavour, texture, and nutritional values (e.g. cheese or wine); (2) precision fermentation, in which an organism is cultured to produce a specific product (e.g. vitamins, flavour molecules) which is separated from the producing microorganisms cells; and (3) biomass fermentation, in which a microorganisms is cultured to form nutritious biomass, which is processed, and formulated into a microbial food product.

Biomass fermentation is the youngest and least utilised form of microbial food production, offering tremendous potential for growth and a meaningful contribution to addressing global environmental challenges. **This COST Action focuses primarily on biomass fermentation for microbial food products.**

The enormous microbial biodiversity can be harnessed to isolate microorganisms with desired properties. For example, microorganisms have evolved to metabolise a variety of substrates, which allows them to grow on industrial waste streams (e.g. whey, olive oil mill waste, sawdust). This means, that besides their production facilities, no additional land is required for their production. Life Cycle Assessments have also shown that **microbial food production's GHG emissions are lower than those of meat products**. Additionally, microbial food production in bioreactors is independent of weather, seasons, and location, **allowing a constant and reliable supply**. An example of a microbial food is *Quorn*, which uses the biomass of the filamentous fungus *Fusarium venenatum*. The development of *Quorn* was a response to concerns of global food shortage and research began in the 1960s. The fungus *F. venenatum* was discovered in 1967 and after about **2 decades of development**, the first product was launched in the UK in 1985. Today, *Quorn* holds about 30% of the UK's meat alternative market.

To reshape the food sector at a European and global level and create a microbial food revolution, more microbial food products with new flavours, consistencies, and nutritional values are needed. Additionally, these **products need to be developed and commercialised at an unprecedented speed** to transform the food sector. Only then can we minimise its global environmental impact and keep global warming well below 2°C above pre-industrial level following the Paris Agreement. **This ambitious goal can only be achieved through an international and interdisciplinary network of experts.**

Mic2Food's investigations will aim at their immediate application and transference to industrial partners avoiding the long-term transition from laboratory to market. By connecting all relevant interdisciplinary stakeholders, *Mic2Food* will accelerate microbial food development and drive the Microbial food revolution in Europe.

1.1.2. DESCRIPTION OF THE CHALLENGE (MAIN AIM)

With the rapid population growth, demand for food is quickly increasing and meeting the global protein supply requirements is becoming a global problem. Plant proteins have been proposed as alternatives to animal proteins, but their production needs big extensions of arable land and demands huge volumes of freshwater which results in considerable environmental issues. The urgent need for alternative proteins requires new strategies to secure diverse nutritional sources. This issue was recognised in the 2023 EU Protein Strategy Briefing, which emphasised the potential of microbial protein for food and feed applications in strengthening the EU's independence from protein imports.

This COST Action, entitled *Accelerating Innovation and Development of European Microbial Foods (Mic2Food)*, aims to facilitate the development of new microbial foods for the European market. *Mic2Food* will create a unique network with a balanced geographic distribution to tackle scientific and technological challenges to make microbial food substitutes a reality. Collectively, *Mic2Food* aims to:

- (1) isolate and identify new, non-pathogenic microorganisms with desired properties for their application as microbial foods, including their protein content and lipid composition, and micronutrient content, and optimise their production properties in line with food regulations.
- (2) develop and upscale their production processes from lab scale (millilitres) over pilot scale (litres) to industrial scale (cubic meters).
- (3) establish downstream processing (DSP) (e.g. removal of RNA) and formulations to produce appealing products that can be commercialised.
- (4) monitor regulatory changes for microbial food and facilitate commercialisation of microbial food products in Europe and worldwide.

- (5) quantify the nutritional and mechanical properties of the microbial strains and food products in a standardised way throughout the development.
- (6) accelerate the translation of microbial food research from academic research to tangible products through close collaboration with established industrial partners.

There are three main specific challenges this Action will address.

The first challenge is the interdisciplinary expertise required to develop a new microbial food from the discovery of the microorganisms to the final product. The European scientific landscape harbours an abundance of qualified labs and institutions that excel in either of the aforementioned areas. However, they are poorly connected and lack cohesion. For example, a lab specialised in microorganism isolation does not have the tools and expertise to evaluate their potential use as microbial foods. Simultaneously, a lab with expertise in up-scaling and DSP is not aware of potential new strains that could be developed into new products. Additionally, both labs lack the instruments and assays to quantify food-specific properties (e.g. digestibility, texture, and taste) and the expertise to navigate the legal landscape required for governmental approval of microbial foods. **This Action will connect the European microbial food landscape to ensure that discoveries are accelerated to the next stage of microbial food development in a coordinated manner, allowing a rapid translation of innovations to tangible products.**

The second challenge is the scale of microbial food development needed to change the food system's environmental impact. Biomass fermentation for human consumption is an emerging field that can leverage the expertise of established stakeholders currently focused on different products. For example, most biotechnological applications currently focus on precision fermentation, i.e. the fermentation of a microorganism to produce either high-value products (e.g. pharmaceuticals, enzymes) or commodity chemicals (e.g. ethanol, citric acid). In precision fermentation, the biomass is secondary and only serves as the biocatalyst to produce the product. While the product is very different, the expertise and equipment for biomass and precision fermentation are very similar, e.g. both involve large-scale cultivations and DSP. This Action will identify the main differences in methods and operational procedures between the current state-of-the-art precision fermentation and the newly emerging field of microbial foods through biomass fermentation (e.g. differences in cell morphology that require adjustments in cultivation and DSP). ***Mic2Food* will tap into the existing potential of European researchers and entrepreneurs, facilitating the application of their skills and knowledge toward advancing microbial food development.**

The third challenge is the public acceptance of microbial food. Because of its novelty, it is widely unknown to the public. Additionally, the association of microorganisms with illnesses results in a low acceptance of microbial foods. Through a **coordinated effort**, by developing and sharing dissemination material suitable for the general public, this Action will **inform and educate the public** about the potential microbial food holds. By **actively seeking the conversation with the public and policymakers**, this Action will **positively influence the public perception** of microbial foods and allow this emerging industry to thrive in Europe.

Mic2Food will overcome these challenges by connecting researchers, entrepreneurs, non-governmental organisations, and established companies (including Small and Medium-sized Enterprises (SMEs) and large business enterprises) across Europe to facilitate the development of new microbial foods. All the aforementioned stakeholders are already part of the proposer network.

1.2. PROGRESS BEYOND THE STATE OF THE ART

1.2.1. APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE OF THE ART

By combining the complementary multidisciplinary expertise of researchers across Europe, the *Mic2Food* mission will go beyond the state-of-the-art. *Mic2Food* brings together experts in microbiology, synthetic biology, biotechnology, fermentation technology, process design, down-stream processing, nutrition, feedstock utilisation, sustainability analysis, regulation, and food analytics, among others.

Mic2Food brings together members (labs, NGOs, companies of different sizes, etc.) specialised in different stages of microbial food development. While each lab excels in a specific stage (e.g. microbial isolation, strain engineering, up-scaling, DSP, formulation, or microbial food analytics), the full development of a new microbial food cannot be managed by a single lab and requires an

interdisciplinary approach. Through the collaborative synergy of this network, the different development stages of microbial food are connected, accelerating the translation of innovations. Furthermore, it increases the awareness of specific requirements and outcomes required for the next development stage. For example, to evaluate the up-scaling potential of an organism certain reference values (titre, rate, yield) can be collected earlier in small-scale cultivation, which can be used during up-scaling to facilitate the development. Another example is the awareness of governmental regulation which should be considered early when modifying microorganisms. This interdisciplinary understanding and awareness further streamline the workflow, increase efficiency and shorten the time of microbial food development.

Apart from the participating NGOs, the *Mic2Food* network's members have different levels of expertise and experience with microbial foods. Broadly, they can be categorized into two groups:

1. **Specialized labs:** labs that have extensive experience in developing microbial foods and are at the forefront of this new field.
2. **Emerging labs:** labs that have extensive experience with relevant methods and technologies but have not yet applied these to the field of microbial foods.

Through this collaborative network, these two groups are brought together. This leads to a rapid exchange of knowledge, allowing a quick modification of existing techniques and approaches to apply them to develop microbial foods. This accelerates the learning curve of the emerging labs and expands the capacities within the network. This allows more stakeholders to partake in the development of microbial foods and leads to the rapid development of multiple new microbial foods in parallel.

1.2.2. OBJECTIVES

1.2.2.1. Research Coordination Objectives

Mic2Food aims to **create a European transnational network that facilitates the development of new microbial foods through biomass fermentation**. *Mic2Food* will establish a scientific platform for cooperation between scientists from different member states, areas, and disciplines. Each member's qualifications are essential for the development of microbial food but not sufficient since this task requires a multitude of expertise. *Mic2Food's* synergistic approach will avoid research fragmentation and allow it to utilise the potential of microorganisms to become a reliable food source in Europe by sharing know-how and distributing research tasks between its members.

Mic2Food will promote **collaboration among research groups across Europe and strengthen partnerships between academia and industry**. A key objective of this Action is to accelerate the transfer of innovative technologies to full-scale applications.

The Research Coordination Objectives include:

- Development of an interdisciplinary and synergetic network, that accelerates the development of new microbial foods in Europe.
- Increase Europe's capacities in microbial food development by applying existing knowledge through targeted collaboration and knowledge exchange between specialised and emerging labs.
- Coordinate research efforts of the network member at a European level and create synergies for further research.
- Increase chances of commercialisation by developing a tractable road map for commercialising research outputs via analysis of market drivers and regulatory requirements, in close consultation with industry stakeholders.
- Dissemination of research results to the general public and other stakeholders to increase the awareness and acceptance of microbial food.

1.2.2.2. Capacity-building Objectives

The capacity-building objectives of *Mic2Food* aim to build the critical mass to drive microbial food development in Europe in accordance with the COST mission and policy. This will be achieved by:

- **Foster a closer collaboration between mentor labs and mentees.** This program will provide guidelines to foster close collaboration between a mentor lab and a mentee lab. It will offer a platform for all stakeholders to

present themselves and facilitate the formation of mentorships. There are two kinds of mentorship that this Action aims to establish:

1. Mentorships between labs of different stages of the development process, including universities, SMEs and global organisations. These partnerships will bridge the separate fields to achieve the aim of this Action.
 2. Mentorships between labs specialised in a similar stage of the development process pairing specialised and emerging labs. These partnerships will accelerate the emerging lab's transition to microbial food applications and increase the capacity of the network.
- **Increase opportunities for exchanging information and promoting collaboration throughout the network.** A database will include all capacities for process development and up-scaling, DSP, formulation development, and analytics of the network. This includes information on equipment (kind, volume, manufacturer, specifications) and expertise and availability of trained personnel (following General Data Protection Regulation). The database will allow members to find collaborators with suitable capacities and expertise for their ongoing projects and promote collaboration.
 - Facilitate productive collaborations between industry and public research by **engaging leading companies** through Training Schools (TS), meetings, Short Term Scientific Missions (STSMs), and round-table discussions.
 - **Support and promote increased participation for researchers in networking activities** with a focus on those activities that are less environmentally harmful and more flexible for the participant, while still acquiring new competencies, e.g. participation in online workshops, collaboration in computation work or preparation of literature reviews. Since this form of collaboration does not require travelling it is less environmentally harmful and more flexible for the participant, while still acquiring new competencies.
 - Promoting the **involvement of Inclusiveness Target Countries** (ITCs) by assigning 50% of the key leadership roles (e.g., STSM Manager, Working Group Leader, Vice-Chair, etc.) to an ITC representative.
 - Promoting **gender balance** and women's participation in leadership roles by assigning 50% of the key leadership roles to women.
 - Training of **Young Researchers and Innovators (YRIs)**, providing them with a far-reaching international network, and assigning 50% of the key leadership roles to YRIs.
 - Support visits to participating research institutions to provide training on technical or methodological aspects, with a particular focus on supporting YRIs.
 - Increase collaboration and accelerate microbial food development through a **stakeholder platform** for the microbial food sector in Europe. **Involve industrial stakeholders through the facilitation of startups.** Encourage the participation of PhD students and YRIs from ITC in international conferences not directly organized by the COST Action using **Conference Grants**.
 - Initiate collaboration with **International Partner Countries** (IPCs) to establish *Mic2Food* in a leading role at the international level through scientific and dissemination activities.

Mic2Foods' members are highly knowledgeable about the state-of-the-art for each task in the Working Groups (WGs). This gives participants clear insight into current challenges and areas requiring further investigation, leading to an effective start in generating results. The necessary resources (personnel, equipment, infrastructure) are already available at the institutions involved, ensuring the Action's goals can be pursued without delay. The partners' recognised expertise ensures full scientific coverage, and their collaboration will accelerate the development of microbial food. This progress would be impossible for any single member to achieve alone. To facilitate collaboration and exchange of knowledge this Action will employ several instruments:

- **Working Group meetings** to evaluate the current state, set targets, and develop strategies to meet objectives, coordinate research efforts, exchange knowledge, and identify further areas of collaboration while keeping the Action adaptable to include new perspectives and address unforeseen emerging issues beyond the implementation stage.
- **Training visits**, facilitated through **STSMs** and **VMs**, to disseminate knowledge and standardize methods and techniques across different research groups.
- **Dedicated dissemination and exploitation activities** during WG meetings targeting industrial stakeholders in Europe (SMEs and large companies).
- **Newsletter and website** describing the past and upcoming activities of the Action.
- **Training Schools (TS)** for PhD students and YRI with different backgrounds and participation in the different WGs.
- **Conference Grants** for PhD students and YRI researchers from ITC.
- **Closing conference** to summarise and disseminate the Action results and to propose further collaborations by interdisciplinary teams of the network.

2. NETWORKING EXCELLENCE

2.1. ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

2.1.1. ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

The food sector has been identified as an area in need of innovation by multiple international organisations, for example, the United Nations (Environment Program 2023), the EU (e.g. Farm to Fork Strategy of 2020), the World Economic Forum (2024), and the *Good Food Institute*, a non-profit organisation, focused on promoting the development of alternative protein. Similarly, the *Bezos Earth Fund* has recently (2024) established three *Bezos Centres for Sustainable Protein* (in the USA, Singapore, United Kingdom) to focus on the development of alternative proteins. **These organisations acknowledge the urgency of changing the food system and point to the need for accelerated development of alternative food.** *Mic2Food* will seek contact with these and other existing organisations to foster collaborations and knowledge exchange.

This COST Action does not overlap with previous or ongoing COST initiatives and is not the continuation of any. The closest initiative is the *PIMENTO* COST Action (CA20128) which focuses on fermented foods and ends in 2025. However, in contrast to biomass fermentation (as focused on in this Action), fermented foods use microorganisms to partly convert an existing food (e.g. milk, cabbage) into a fermented food (e.g. cheese, fermented cabbage). While this process yields additional aroma compounds and has cultural value, it is not suitable for addressing the global environmental challenges caused by the food sector. In contrast, the biomass fermentation approach of *Mic2Food* converts substrates, e.g. sugar or waste streams, into microbial biomass rich in protein and nutrients that is further processed to form microbial food. Through this approach, microbial food can significantly contribute to a sustainable food sector. Another related COST Action is *YEAST4BIO* (CA18229), which ended in 2023 and focused on non-conventional yeasts for bioproduct production in general. *YEAST4BIO* was not focused on food applications, mainly used precision fermentation, and only focused on yeasts as microbial hosts. The *Mic2Food* Action will draw on the expertise of previous COST Actions to create a successful initiative.

In summary, while **alternative food has been identified as an urgent subject** at European and international levels, ***Mic2Foods'* approach** of systematically assembling a network of all stakeholders of microbial food development and expanding the capacities of the network through targeted mentoring of emerging labs, **is unique and adds value to existing efforts.**

2.2. ADDED VALUE OF NETWORKING IN IMPACT

2.2.1. SECURING THE CRITICAL MASS, EXPERTISE AND GEOGRAPHICAL BALANCE WITHIN THE COST MEMBERS AND BEYOND

This Action network has the critical mass, expertise, and geographical balance to address the challenges of accelerating the development of microbial food in Europe. At the time of proposal, the network consists of 36 proposers from 17 COST full members, 9 of which are ITCs, and is geographically balanced. The highly interdisciplinary network covers all core expertise needed for microbial food development. Specialised labs with previous experience in microbial food research are distributed across all WGs. Additionally, the involvement of 6 companies (SME and large companies) provides a crucial experience beyond the academic realm and will support the commercialisation of new microbial food products. Through the involvement of non-governmental organisations (NGOs) specialising in alternative foods, this Action has the resources to rapidly expand further and disseminate its outcomes to a broad audience.

Over the next 4 years, *Mic2Food* will build a network of over 300 members across Europe resulting in a long-term impact for the European food sector. During *Mic2Food's* growth, the Management Committee (MC) will **monitor the balance of the network** regarding ITCs, gender, YRIs, and core expertise and initiate targeted recruitment to restore any imbalances if necessary.

2.2.2. INVOLVEMENT OF STAKEHOLDERS

The development of microbial foods requires the involvement of different stakeholders. Thus, outcomes derived from the Action will have a clear impact on scientists working in different disciplines (biology, chemistry, biotechnology, nutrition, etc.) but also intend to impact other actors such as European policymakers and the general public.

The Action will bring together several stakeholders including (1) researchers and specialist staff, (2) teachers and lecturers from renowned Universities, (3) industrial partners from world-leading European companies specialised in scale-up and custom manufacturing of bio-based products and processes, as well as (4) NGOs and (5) EU bodies.

Researchers and specialist technical staff will train PhD students and Young Researchers and Innovators (YRI). This will be achieved by taking advantage of several networking tools such as STSMs and VMs in which well-established investigators from foreign labs will train visitor researchers. Regular networking events, e.g. WG meetings, will allow coordination of collaborative research efforts to maximise outcomes of existing researcher funding and development of joint research projects.

Teachers and lecturers from academia will include outcomes and insights of the Action in their educational program, providing up-to-date knowledge to the next generation of researchers. This will ensure a long-term supply of qualified next-generation researchers for the microbial food industry.

Chefs from restaurants and research institutes will participate in all activities of the Action. Their experience with handling different kinds of food and using new ingredients in innovative ways will allow them to create novel dishes that will attract the interest of the public and thereby increase the acceptance of microbial foods.

Industrial partners will participate in roundtable discussions and play an active role in all activities of the Action. Industrial participants will actively participate in the organisation of Training Schools (TS) and host STSMs to promote collaborations aiming at fostering the commercialisation of new microbial food products. Their expertise in the creation and protection of intellectual properties (IP) will help to secure IP rights of innovations resulting from the collaboration of this network and build the foundation of new microbial food products and companies. Additionally, new companies will be approached with targeted dissemination and exploitation activities for SMEs and large companies in Europe, particularly during the first WG meeting to attract more industrial participants.

An **Innovation Committee** (IC) will be formed, including industrial partners and academic representatives, to encourage cross-sector discussions on the potential for exploiting research results. The IC will meet during the WG meetings and, when needed, through teleconferences.

NGOs will participate in disseminating the results to the public and provide feedback from the public (e.g. surveys on food preferences, or characteristics of alternative foods) to the Action network and take part in Action activities. Additionally, their established outreach channels will be used to promote this Action facilitating its expansion.

The **independent EU body** will participate in group meetings and discussions and provide direct access to a research funding body. This connection will be particularly valuable to YRI by receiving direct feedback on their funding applications.

NGOs and members of **regulatory bodies** will actively participate in discussions and WG meetings to raise awareness of the regulatory landscape of microbial food and to provide advice to scientists and innovators during the process of commercialisation.

3. IMPACT

3.1. IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAKTHROUGHS

3.1.1. SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

This Action will benefit the research and development of microbial foods in Europe and its innovations will have scientific, technoeconomic, and socioeconomic impacts in Europe and beyond.

In the **short term**, the collaboration between members will reduce research fragmentation by fostering a comprehensive and interdisciplinary approach. Resulting collaboration will lead to scientific and technological innovations. *Mic2Food* will also support the career development of YRI and PhD students by offering a complete range of training, scientific exchange and networking activities, which may result in more job opportunities in both research and industry.

In the **long term**, the collaborations between Action participants will result in codified knowledge in the form of scientific publications and patents. The existing bottleneck of knowledge fragmentation will be overcome, resulting in the accelerated development of microbial foods in the future beyond the duration of this Action. Through the targeted integration of ITCs the European microbial food landscape will be united and the research capacities of ITC members will be strengthened.

The development of microbial foods will result in new products and services with **high socioeconomic impact**. The developed microbial foods will enhance the sustainability of the food sector and directly contribute to the **European Green Deal** and several **UN sustainability goals** (Zero Hunger, Responsible Consumption and Production, Climate Action, Life on Land). Furthermore, the developed microbial foods will also decouple food production from weather and seasons increasing the European food security and autonomy. With an estimated size of \$2.1 billion in 2024 the microbial food culture market has enormous economic potential. **This Action will help to establish Europe as a key player in this emerging market.**

By implementing new technologies and alternative microbial food in SMEs, this Action will increase the European economy's competitiveness. All stakeholders will establish a cluster to achieve the commercialisation of new microbial food produced from biomass producing high impact in the industrial sector. Thus, this Action's results will have far-reaching consequences for both industrial and societal benefits. Those benefit the food sector, and positive effects will also be observed in many other industry segments, such as the pharmacological, nutritional and chemical industries.

Mic2Food foresees several potential innovations and breakthroughs such as:

- Identification and modification of microorganisms with high potential for microbial food applications.
- Standardise the characterisation of microorganisms and microbial food products.
- Development of novel technologies and approaches for biomass fermentation processes.
- Initiate the commercialisation of novel microbial food products with industrial partners and the foundation of new start-ups producing microbial food products.

3.2. MEASURES TO MAXIMISE IMPACT

3.2.1. KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

The network will create and transfer knowledge and benefit the career development of its members in several areas of expertise (biotechnology, microbiology, nutrition, analytical chemistry, etc.).

Academic partners in *Mic2Food* have a strong knowledge of microbial discovery, characterisation, modification, and cultivation that will be complemented with the participation of 6 companies with expertise in large-scale production, DPS, formulation, and commercialisation.

New knowledge is created by coordinating the research efforts of labs to reach the objectives. Network members will develop new research ideas and apply for joint research grants resulting in additional knowledge creation. Furthermore, through the joint preparation of reviews, databases, and white papers, knowledge is connected and consolidated.

Knowledge is transferred during WG meetings, STSMs, VMs, and training schools (TS). The Action will plan and host three TSs, each covering different aspects of microbial food product development. The TSs will cover:

- TS1 – Development of platform strains for microbial food applications.
- TS2 – Up-scaling and DSP of microbial food production processes.
- TS3 – Formulation development and food chemistry for microbial foods.

Additionally, the tacit knowledge from networking activities will result in long-term collaborations between members that will go beyond the time of this Action, fostering knowledge exchange and improving the career perspectives of the participants.

The career development and employability of members will be increased through participation in this Action's activities (e.g. STSMs, VMs, TS, WG meetings, etc.). To specifically support the career

development of YRIs, at least 50% of the STSMs and VMs will be awarded to YRIs. Furthermore, the participation in leading roles in this Action allows members to develop additional transferable skills (e.g. leadership and management skills). Similar to the STSMs, 50% of the leading roles of this Action will be covered by YRIs improving their organisational and leadership skill and thereby their career development. The Action's interdisciplinary and international network will improve the career perspectives of all participants. Through the diverse dissemination approaches (see 3.2.2), the Action will be established as a known entity in the alternative food sector leading to targeted recruitment of network members by companies.

3.2.2. PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

Both, planetary health and food are highly relevant and relatable topics for the general public and policy. This Action will use individual dissemination approaches tailored to the different target audiences, which include:

- **Researchers** in academia and industry, including both, participating and non-participating individuals are the immediate beneficiaries of research activities.
- **Industrial stakeholders** with the potential to contribute to the development of microbial foods.
- **European policy makers** including those shaping the regulatory landscape of microbial foods and those outlining future European funding strategies.
- **Society and the general public** forming the basis for future consumers of microbial foods and will be aware of the new advances making Europe a key player in the global market of microbial foods.

Scientific results will be disseminated through established ways such as publications of research and review articles in high-impact peer-reviewed journals (e.g. Nature Food, Nature Communications, Bioresource Technology, Trends in Food Science and Technology). The coordination of research projects will focus on geographically balanced participation, ensuring the participation of ITC authors and promoting the leading authorships to YRIs. To ensure the availability of the results to the public, all results are made available through open-access publications. To reduce the delay between discovery and publication, articles are made available in open depositories (e.g. bioRxiv) in parallel to the reviewing process. Additional dissemination of scientific results includes the publication of book chapters and presentations at conferences (e.g. *FOOD MICRO* by the *International Committee on Food Microbiology and Hygiene*, or the *International Conference on Microbial Food and Feed Ingredients* (MiFFI)) and WG meetings. The dissemination of results and networking activities will be managed through Management Committee (MC) meetings, WG meetings, newsletters, TS, STSMs, and a closing conference. All dissemination efforts will be shared on the Action's website and coordinated by WG6. A dedicated website will be created to provide regular updates on the WG's progress and developments.

Students will be reached through new innovative teaching material, developed by the network and delivered by lecturers and academic teachers. The network will develop a new free open online course on microbial food, giving access to students and the interested public worldwide. This will increase the acceptance of microbial food and ensure a growing qualified workforce for the expanding microbial food industry.

The **exploitation** of scientific results is reached through securing intellectual property rights (IPR) through patenting. This is facilitated through legal offices/units in research institutes that will work with the network.

Policymakers will be approached through public discussion and white papers summarising the potential of microbial foods for Europe.

All participants will increase the visibility of the COST Action by acknowledging the COST's contribution by including the Action acronym and the COST logo in all associated disseminations according to COST rules.

The general public will be reached through science blogs, radio and TV interviews, popular science articles, and participation in science festivals (e.g. local festivals, and the European Researchers Night). Whenever the format allows, interviews, surveys and other tools are used to gather insight into the public opinion and foster the dialogue between science and the general public. Additionally, participation in *Women & Girls in Science Day* will facilitate to closing of the gender gap in STEM fields.

All target groups will be reached through a bi-monthly newsletter containing updates of the WGs, announcements of upcoming Action activities and recaps of recent Action events. Additionally, all target groups will be reached through an Actions Website containing:

- Overview of the Actions aims, objectives, and working groups
- Updates on the work development of each working group
- Announcements of Action events, e.g. STSMs, VMs, ITC conference grants and TS
- Information about relevant external events e.g. conferences, webinars
- Updates on publications and conferences attended or organised by Action members
- Posts of a regular newsletter, and the option to register to receive the newsletter via email
- Job listing of open positions in the field of microbial food
- Links to additional social networks

4. IMPLEMENTATION

4.1. COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

4.1.1. DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

To achieve the aim of accelerating the development of microbial foods in Europe, this Action maintains 5 work groups (WG). WGs have been designed as detailed below:

WG1 – Microorganism discovery, characterisation, and optimisation for microbial food applications.

This WG focuses on the discovery, characterisation, and optimisation of microorganisms for their application as microbial foods through biomass fermentation. The global microorganism diversity is estimated to be 1 trillion species, and only a fraction has been isolated, characterised or utilised. Harnessing this biodiversity allows us to find strains for microbial food with better texture, taste, and nutritional values. Microorganisms can either be new isolates of strains sampled and purified from diverse environments or from existing strain collections that have not been screened for potential microbial food strain candidates. Strains isolated from food sources will be prioritised as those already part of the human diet and likely not harmful. The characterisation includes species identification through genome sequencing, growth assays with different carbon and nitrogen sources, and food chemistry assays to evaluate the strain's biomass composition in terms of macro (protein, lipids) and micronutrients (vitamins and minerals). Strains with promising characteristics will be further optimised through established methods. These include traditional methods (e.g. random mutation followed by selection, and Adapted Laboratory Evolution) or targeted modification via *New Genomic Techniques*. If not already available, genetic tools and protocols for targeted modification will be adapted from closely related species. To comply with EU regulations, no transgenic material will be transferred to the organisms and any modification will follow precision breeding techniques. These techniques will result in a precision-bred organism (PBO) instead of a genetically modified organism (GMO), which eases regulatory hurdles in the approval process of microbial foods.

Tasks

- T1.1 Create a database of available strain isolates that can be characterised by their microbial food potential.
- T1.2 Prepare content for TS1 on the *Development of platform strains for microbial food applications* in collaboration with WG5 and WG6.
- T1.3 Compile a library of standardised assays to characterise microorganisms to evaluate their microbial food potential.
- T1.4 Shortlist microorganisms with potential for microbial food that should be further optimised.
- T1.5 Coordinate optimisation of promising microorganisms between members by exchanging microbial engineering tools and establishing novel collaborations.

Activities

- A1.1 Organisation and implementation of bi-annual WG meetings.
- A1.2 Participate in teaching activities of TS1.

WG2 – Development and up-scaling of production processes for microbial foods.

This WG focuses on the development and up-scaling of production processes for microbial foods. Since each microorganism has evolved in different environments, its growth requirements are different. This requires specialized solutions tailored to each organism regarding their optimal temperature, aeration,

mixing, pH, nutrient concentration, etc. These tasks are very equipment-heavy and only a few institutions are specialised in this task. Additionally, biomass fermentation can differ substantially from more established precision fermentation because of preferred cell morphologies needed to create consistency (e.g. filamentations or flogging) resulting in new challenges for the process development (e.g. inhomogeneous mixing, clogging of tubing).

Tasks

T2.1 Identify challenges in process development and up-scaling specific to biomass fermentation compared to precision fermentation.

T2.2 Prepare content for TS2 on *Up-scaling and DSP of microbial food production processes* in collaboration with WG3 and WG6.

T2.3 Coordinate collaboration with members of WG1 to develop production processes for novel microbial food strains.

T2.4 Create a catalogue of established solutions for biomass-fermentation-specific challenges.

Activities

A2.1 Organisation and implementation of bi-annual WG meetings.

A2.2 Participate in teaching activities of TS2.

WG3 – Downstream processing and formulation development for microbial food products.

This WG focuses on the downstream processing (DSP) and formulation development for microbial foods. The harvesting and processing (e.g. RNA removal) of biomass requires specialised equipment and needs to be adjusted for each microorganism and application because of different media compositions, cell sizes and morphologies, and cell compositions. Additionally, this step has high energy requirements, which means that an optimisation of this step can greatly impact the overall sustainability of the process. Formulation development refers to different preparation methods (e.g. freeze-drying, adding binding agents, e.g. starch), ingredient combinations, and cooking (e.g. microwaving, baking, frying, steaming). This step defines the final microbial food product and must be adjusted to the consumer's needs and preferences, as it severely influences taste and consistency.

Tasks

T3.1 Identify challenges in DSP of biomass fermentation compared to precision fermentation.

T3.2 Identify customer needs and market opportunities for microbial foods that can be addressed by formulation development by conducting surveys and meta-analysis of existing surveys.

T3.3 Prepare content for TS2 on *Up-scaling and DSP of microbial food production processes* in collaboration with WG2 and WG6.

T3.4 Coordinate collaboration with members of WG2 for DSP and formulation development for novel microbial foods.

T3.5 Prepare content for TS3 on *Formulation development and food chemistry for microbial foods* in collaboration with WG3 and WG6.

Activities

A3.1 Organisation and implementation of bi-annual WG meetings.

A3.2 Participate in teaching activities of TS2.

A3.2 Participate in teaching activities of TS3.

WG4 – Food chemistry and analytics for microbial foods.

This WG focuses on the food chemistry and analytics of microbial foods. Microbial food can be analysed for its macro- (e.g. protein and lipid) and micronutrient (e.g. vitamins, minerals) content but methods for these quantifications are not standardised for microbial foods yet. This WG will coordinate the adaptation of existing protocols for conventional food (e.g. grains, fruits, fish and meat) to microbial foods by following the principles of the Periodic Table of Food. These methods can be applied to strains of WG1, to identify those with beneficial properties. Beneficial properties can be a high protein content containing large proportions of essential amino acids, those that the human body can not produce and need to be acquired through food; or a high content of vitamins (e.g. vitamin B12) and other micronutrients (e.g. carotenoids that have antioxidative properties and have health benefits). Additionally, the knowledge of this WG will also be applied to formulated products of WG3. This includes additional assays on digestibility, consistency, and flavour and allows an extensive characterisation of the microbial food product.

Tasks

T4.1 Compile a library of standardised assays to analyse microorganisms to evaluate their microbial

food potential.

T4.2 Coordinate collaboration with members of WG1 to evaluate the potential of novel microbial foods strains.

T4.3 Agree on standardised assays to analyse microbial foods.

T4.4 Coordinate collaboration with members of WG3 to evaluate novel microbial foods.

T4.5 Prepare content for TS3 on *Formulation development and food chemistry for microbial foods* in collaboration with WG3 and WG6.

Activities

A4.1 Organisation and implementation of bi-annual WG meetings.

A4.2 Participate in teaching activities of TS3.

WG5 – Commercialisation and regulation of microbial food

This WG focuses on the last step of the microbial food development process – commercialisation and regulation. This WG works closely with industrial partners, NGOs, and regulatory bodies to monitor the legal frameworks, and food safety and labelling standards, to identify challenges and opportunities for microbial food products. Early identification of these challenges and opportunities is essential to accelerate the development of microbial foods and will be communicated with all other WGs. Furthermore, this WG will support the commercialisation of microbial food products of WG3 through industrial collaborations and contacts with start-up incubators. Additionally, the WG will organise “pitch-your-idea” events, in which members can pitch their microbial food products and receive feedback from industrial partners, which will improve their chances to receive funding or directly result in collaborations.

Tasks

T5.1 Prepare content for TS1 on the *Development of platform strains for microbial food applications* in collaboration with WG1 and 6.

T5.2 Create a roadmap to commercialisation that identifies bottlenecks in microbial food development.

T5.3 Advise policymakers in regulatory decisions regarding microbial foods.

T5.4 Support entrepreneurial activities by organising yearly “pitch-your-idea” events.

Activities

A5.1 Organisation and implementation of bi-annual WG meetings.

A5.2 Participate in teaching activities of TS1.

A5.3 Organisation and hosting of yearly “pitch-your-idea” events that prepare members to pitch for entrepreneurial funding.

WG6 – Dissemination, training and events.

This WG focuses on the dissemination of results and coordination of training and events for members. The training includes 3 training schools (TS). Each of the 3 TSs will be prepared in collaboration with two of the 5 WGs and cover aspects of microbial food development:

TS1 – Development of platform strains for microbial food applications (WG1 and 5)

TS2 – Up-scaling and DSP of microbial food production processes (WG2 and 3)

TS3 – Formulation development and food chemistry for microbial foods (WG 3 and 4)

The **TSs** are open to all members regardless of their background. Participation will enable members to gain a full overview of the development process of microbial foods. Participating PhD students will be awarded credit points that will be applied towards their graduate school requirements.

STSMs will enable researchers to visit partner institutions. STSMs within the same WG will allow an exchange of knowledge within similar backgrounds and will be encouraged during years 1 and 2. STSMs bridging different WGs will facilitate interdisciplinary knowledge exchange and promote understanding of the requirements of neighbouring stages of microbial food development and will be encouraged during years 3 and 4. At any time, 50% of the STSMs will be dedicated to ECIs to promote the career development of the next generation of science investigators.

Additionally, Virtual Mobility (VM) grants will support the remote collaboration of participants, e.g. participation in online workshops, collaboration in computation work, or preparation of literature reviews.

Dissemination is promoted through different measures including the preparation and maintenance of a website and LinkedIn page, regular newsletters via email and publication on the website (details in 3.2.2).

Tasks

T6.1 Creation and maintenance of the *Mic2Food* website and LinkedIn page.

- T6.2 Creation and maintenance of the capacity database of the network.
- T6.3 Collection of dissemination opportunities to the public, e.g. recruiting members of the network for interview opportunities (popular science articles, radio, TV).
- T6.4 Collection of educational material for lecturers and academic teachers.
- T6.5 Organisation of Management Committees meetings, and WG meetings.
- T6.6 Launching of calls for STSMs VMs and coordination of their distribution.
- T6.7 Coordination of TSs with members of WG1-5.

Activities

- A6.1 Organisation and implementation of bi-annual WG meetings.
- A6.2 Participation in public outreach activities, e.g. local science festivals to increase understanding and acceptance of microbial foods and surveys to receive feedback from the public.
- A6.3 Active participation and promotion of dissemination opportunities, e.g. interviews, popular science articles, etc.
- A6.4 Organisation and implementation of MC meetings in coordination with other WGs.

4.1.2. DESCRIPTION OF DELIVERABLES AND TIMEFRAME

D1 Database on available microorganisms and strains (WG1) (Q4 2025 – Q2 2026)

The database includes all microorganisms available to the network from public and commercial strain collection to lab-owned collection and is established in the first three quarters of the Action. The database includes information on their IP status and available data, e.g. genome sequencing and growth performance in different media (e.g. different carbon and nitrogen sources or the presence of toxins) and will be systematically maintained by the network throughout the Action.

D2 Shortlist of microorganisms with beneficial properties for microbial food development (WG1)(Q3 2025 – Q1 2028)

This shortlist highlights microorganisms and strains that showed promising microbial food properties in standardized assays and will be finished in Q1 2028. These microorganisms will be further optimised with different tools by WG1. The shortlist will be published on *Mic2Food's* website after IP has been secured for the most relevant strains (following the Nagoya Protocol). This approach allows this knowledge to be transferred to other researchers while also providing the legal foundation for new microbial foods, an essential step for the commercialisation process.

D3 Standardised protocol collection to evaluate microbial food products and the potential of strains for microbial food development (WG4) (Q1 2026- Q1 2028)

This collection of protocols allows different labs to evaluate microbial food products and strains in a standardised manner. This means that strains, tested by different labs, can be compared more reliably to identify the most promising microbial food candidates. For microbial food products, it includes protocols to determine their mechanical properties, nutritional values (macro- and micronutrients), digestibility, and taste. For microbial strains, it includes standardized protocols for their cultivation (e.g. media compositions, culture conditions), measurement of key performances (e.g. biomass, protein and lipid content), and morphological documentation (e.g. formation of filamentation).

D4 Website, newsletter, and social media presence (WG6) (Q4 2025)

The website, newsletter, and LinkedIn page will be used to disseminate the results and events of the Action (details can be found in 3.2.2) and will be established in the first quarter of the Action and maintained throughout the Action.

D5 Collection of information material and activity instruction for public engagement events (WG6) (Q1 2026 – Q4 2027)

The public will be reached in different events (e.g. public forums, science festivals, interviews, surveys) throughout the Action. This collection of material (e.g. texts, illustrations, presentations, statistics, surveys) and activity instructions (e.g. science experiments for different audiences and event concepts) will be a valuable resource for researchers and facilitate their participation in outreach events. The collection will be made available on the Action's website.

D6 Review on formulation development for microbial food and its influence on product properties (WG3, WG4) (Q2 2028 – Q2 2029)

This review summarises the state-of-the-art of formulation methods for microbial food products and how they influence product properties such as taste, texture, and nutritional values. It will also cover consumer preferences that are provided by NGOs of the network.

D7 Review of established solutions for biomass-fermentation-specific challenges (WG2) (Q1 2028 – Q1 2029)

This scientific review will identify specific challenges encountered by biomass fermentation compared to precision fermentation and outline established solutions to overcome them.

D8 White paper on the landscape of the European microbial food sector (WG5) (Q1 2027 – Q2 2029)

The white paper summarises the potential and challenges of microbial food development in Europe as identified by the *Mic2Food* network throughout the Action. It is specifically addressed to policymakers to inform them and pave the way for the long-term development of microbial foods in Europe. It is prepared in the last 3 quarters of the Action and the final version is presented at the closing conference.

D9 Content for TS1-3 (all WGs) (throughout the Action)

The content includes presentations, instruction for partner and group activities, and the TS syllabus. The content will be used in TS1-3 and will be made available to participants and network members.

D10 Creation of a free open online course on Microbial food (WG6) (Q1 2028 – Q3 2029)

The content of TS1-3 and additional original course material will be used to create a free open online course on microbial food. Students and the interested public can enrol for free to expand their knowledge on this topic. This will train the next generation of researchers and increase the acceptance of microbial food in general. At least one of the co-applicants already has experience in organising a free open online course.

4.1.3. RISK ANALYSIS AND CONTINGENCY PLANS

The Management Committee (MC) will oversee Action-level risks using established planning and control methods. Risk management will be an ongoing process led by the Chair and Steering Committee (SC), with risks identified and addressed during each WG meeting. Working Group leaders will maintain and update a Risk Statement Form, outlining each risk and its potential impact on the Action, allowing for proactive management and mitigation.

In the event of a dispute, the Action Chair will be notified to assess its impact on the Action. After consulting with the SC, the Action Chair will decide on a resolution strategy and assign the issue to a partner or group for resolution. The Action Chair will monitor progress and ensure the process is documented and shared with the Action members. For major issues or delays, the Chair will promptly communicate with members to agree on and implement corrective actions early on.

There are several risks associated with the work plan of this Action, which are listed below together with appropriate contingency plans:

Risk 1 – Drop-out of essential members with unique experience in the development process of microbial foods (risk level low).

The development of microbial food requires the expertise of multiple disciplines, which must be provided by different members of the network. If only one or a few members cover one stage of the development, the workflow risks collapse if those members become inactive, e.g., because of lost funding or too much workload. To de-bottleneck the process and avoid this risk of collapse, the network has redundancy for each stage of the development process. Additionally, should areas with low coverage of expertise emerge, targeted recruiting of new network members will be initiated to strengthen the area in question.

Risk 2 – Changes in the regulatory landscape preventing microbial foods (risk level low).

Many regulatory bodies, including the EU, have acknowledged the potential of microbial food to mitigate the effects of climate change. A massive regressive change in the regulation of microbial food is not likely. To further mitigate the risk, regulatory experts are part of the network from the start. Should harsher regulation be implemented, the Action network will utilise the experience of members who are experts in the regulatory affairs of microbial foods. The experts would prepare a summary and classification of the changes and their implications for the network, which would be distributed via email.

Risk 3 – Natural disasters that prevent networking events (risk level low)

Recent years have shown that different events, such as pandemics, can prevent in-person networking events. But also, regional events, such as natural disasters and political instability can prevent part of the network from participating in events. In this case, events will be adapted to allow online participation. In severe cases, the network can be used to find host arrangements to allow affected researchers to continue their studies and contribute to the objectives of this Action.

Risk 4 – Data management and sharing Issues (risk level medium)

The collaboration of an international network requires the sharing of data and adequate data management. There is a medium risk of mistakes in data management or variability in the way of sharing

data. To mitigate this risk a data management plan and guidelines are developed by the MC during the first MC meeting. This plan will ensure that data is collected in a standardised manner, managed properly, and follows the FAIR principles (findability, accessibility, interoperability, and reusability).

Risk 5 – Ethical or public perception (risk level medium)

Because of its novelty, microbial foods can face a critical ethical or public perception. To mitigate this, the network will use different dissemination approaches to reach and educate the public (see 3.2.2). These approaches are designed to be transparent and foster dialogue between the public and the network, enabling the Action to understand and address public concerns effectively. The communication will be tailored appropriately to the target audiences by using plain language and avoiding confusing technical terms.

Risk 6 – Limited engagement of industrial partners for commercialisation (risk level medium)

To reach the goal of accelerating microbial food development in Europe, industrial partners must engage in the process and support the commercialisation efforts of promising innovations. A limited engagement of industrial partners in this last important step of the development process would reduce the impact of this Action. To mitigate this risk, multiple companies are part of this COST Action from the beginning and more companies will be approached to join the network. Additionally, the active participation of industrial partners will be promoted during workgroup meetings.

Risk 7 – Development of competing technologies such as plant-based and cultured meat (risk level very low)

There is a very low risk, that rapid developments in competing technologies such as plant-based and cultivated meat are increasing the market-entry hurdles for microbial food products. This development could result in reduced greenhouse gas emissions and would be a favourable development. Nevertheless, it is highly improbable that a single solution will be able to occupy the whole alternative food market. Human preferences, cultures, and tastes are too different for a winner-takes-it-all situation. Instead, the solution to revolutionise the food sector is more likely to be found in a diverse mix of alternative food products with different tastes, textures and nutrient values. By streamlining the parallel development of microbial foods this Action is well-positioned to achieve its goals. Developments of competing technologies will be constantly monitored by the Innovation Committee (IC), which will notify members through the newsletter. This will allow *Mic2Food* to apply new trends (e.g. flavours, colours, etc.) to its emerging microbial food products.

4.1.4. GANTT DIAGRAM

Merged cells in the *Tasks* row represent the time frame in which the corresponding task is being performed, while the quartal (Q) of the *Deliverables* row marks the time point when the corresponding deliverable should be achieved. X represents the occurrence of different meetings and recurring activities.

		2025	2026				2027				2028				2029			
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
WG1	Tasks	T1.1			T1.2		T1.3		T1.4		T1.5							
	Deliverables			D1		D9				D2								
WG2	Tasks	T2.1		T2.2				T2.3		T2.4								
	Deliverables							D9						D7				
WG3	Tasks	T3.1		T3.2		T3.3		T3.4		T3.5								
	Deliverables							D9					D9		D6			
WG4	Tasks	T4.1		T4.2		T4.3		T4.4		T4.5								
	Deliverables								D3				D9		D6			
WG5	Tasks	T5.1				T5.2				T5.3								
	T5.4 "pitch-your-idea" events					X			X				X					
	Deliverables					D9										D8		
WG6	Tasks	T6.1 - T6.4																
	T6.5 MC meeting	X			X			X			X			X				X
	T6.5 WG meeting		X		X		X		X		X		X		X		X	
	T6.6 STSMs & VM			X		X		X		X		X		X		X		
	T6.7 Training School					T1				T2				T3				
	Deliverables	D4								D5							D10	