International Journal of Microbiology and Biotechnology
2022; 7(4): 159-162
http://www.sciencepublishinggroup.com/j/ijmb
doi: 10.11648/j.ijmb.20220704.11
ISSN: 2578-9678 (Print); ISSN: 2578-9686 (Online)

Preservation Through Fermentation, a Natural and Sustainable Process – Opportunities, Risks and Regulation: Opinion from LABIP Expert Workshop

Svend Laulund[1, *], Aat Ledeboer[2], Esben Laulund[1]

[1]Chr Hansen A/S, Hoersholm, Denmark

[2]Lactic Acid Bacteria Industrial Platform, Rotterdam, The Netherlands

Email address:

dksl@chr-hansen.com (Svend Laulund), labip.secretary@kpnmail.nl (Aat Ledeboer), dkel@chr-hansen.com (Esben Laulund)

[*]Corresponding author

To cite this article:

Svend Laulund, Aat Ledeboer, Esben Laulund. Preservation Through Fermentation, a Natural and Sustainable Process – Opportunities, Risks and Regulation: Opinion from LABIP Expert Workshop. *International Journal of Microbiology and Biotechnology*. Vol. 7, No. 4, 2022, pp. 159-162. doi: 10.11648/j.ijmb.20220704.11

Received: July 28, 2022; **Accepted**: August 19, 2022; **Published**: October 21, 2022

Abstract: The Farm to Fork Initiative by the European Union (EU) has set ambitious goals with the overall objective to ensure that all foods on the EU market are sustainable. By applying fermentation technology in the production of food, the European food industry is given excellent opportunities to fulfill these goals. Food products that are produced using fermentation are also generally regarded by consumers as safe, natural, sustainable, and environmentally friendly. But the European Commission (EC) and some member states are discussing whether preservation by fermentation, with only a small sensory effect, should be regulated like chemical preservatives according to the food additive regulation. Consequently, the EU is at risk of missing out on the natural and sustainable potential of the fermentation technology. To understand and pave the way for a revival of fermentation as a natural and safe biological way to reduce food waste and secure a more sustainable food production, an expert workshop was organized by LABIP to discuss the science behind the preservation of foods through fermentation and the opportunities, risks, and regulation in the EU The conclusions and recommendations from the expert workshop are presented in this LABIP Position paper.

Keywords: Fermentation, Food Production, Preservation, EU Food Regulation

1. Introduction

The increased global consumer trends towards a more sustainable food production and reduction of food waste have revived the search for new preservation technologies for food production. In this context the ancient technology of fermentation has seen a revival in the production of both industrially as well as artisanal produced foods [10]. Increased preservation by fermentation has also the potential to support the European Commission's strategy to reduce the general use of chemicals [6] and to live up to United Nations' Sustainable Development Goals [5].

Fermented foods are foods that have undergone a process of acidification, maturation, ripening, flavoring and preservation through targeted microbial growth and related enzymatic conversion of the food components. Fermentation results in desired final food product characteristics, such as sensory properties, improved product stability, and enhanced nutritional value.

Fermentation has historically been a technology used by humans during several millenniums to preserve nutrients found in perishable food raw materials. The technology of fermentation has since been industrialized, leading to safe and controlled fermentations. However, other preservation methods, based upon chemicals (e.g., salt, acids, chemical preservatives) or temperature control (pasteurization and sterilization) have during the last century increasingly been the dominant preservation methods in the food industry.

With more than 30% of all foods for human consumption being produced using fermentation [17], this traditional technology still plays an important role in reducing food waste and securing natural and sustainable food production.

It is furthermore estimated that up 1/3 of all foods for human consumption is wasted before it is consumed [9].

Fermentation technology therefore provides the food industry with a natural and sustainable way of producing safe food products, with extended shelf life, thus reducing food waste and meeting consumer demands for natural foods with reduced use of chemical preservatives. Cultures for fermentation of foods are today categorized as ingredients in the EU General food law [12]. But the European Commission and the member states are discussing whether the fermentation cultures, having a preservation effect with only a small sensory effect, should be regulated as a chemical additive according to the food additive regulation and consequently be labelled as additives [13]. However, it is not a good solution to categorize food cultures into two different regulatory categories according to their intention of use as the same culture species will then belong to both regulations. The additional cost and work for the approval of cultures going through EFSA etc., will be an unnecessary burden for both the food industry and the EU system. This approach from the EU regulatory bodies creates a lot of uncertainties for academia and the food industry. Especially regarding the challenge of limiting the use of animal-based food and increase the use of plant-based food, that by use of LAB can be converted to pleasant, tasty dishes with extended shelf life [1] which will convince people to use a more sustainable diet.

The Lactic Acid Bacteria Industrial Platform (LABIP), established in 1994, is a European Economical Association with the aim to act as the industry platform for EU-funded research projects within lactic acid bacteria (LAB) and its industrial applications. Members of LABIP are companies that produce or use LAB and have research and production facilities for LAB in the EU. LABIP sees it as one of its main tasks to organize expert workshops with relevant recognized experts on topics of interest for industry, academia, and EU authorities. LABIP was the organizer and sponsor of the expert workshop "Bio-preservation through fermentation, a natural and sustainable process – Opportunities, Risks and Regulation" held in Bruges, Belgium, 27-28 September 2021.

2. The Role of Fermentation in the Production of Foods

Fermentation is a natural process based on growth of microorganisms (prokaryotes and eukaryotes) present or having been added to the food product during the manufacturing process. The microorganisms that grow during the production process are favored by the nutrients available and the micro-environment in the food product matrix like temperature, O_2 level, osmotic pressure, and humidity [3].

The fermentation technology has in recent centuries been seen more as a method to obtain specific characteristics of a given food product, such as different cheese types, fermented milks, beer, wine, salami, and cured whole meat, than as a way of preserving the food. But in the early days of human civilization fermentation of food was an important way to preserve essential nutrients from perishable raw materials [14].

The characteristics of the different fermented foods are often a result of the environmental, climate and societal conditions in a particular geographical area. This can be seen even within the boundaries of France where a large variety of specialized cheese types have been created. Due to the humidity and abundant availability of grass for milk production yearlong in Normandy, the Brie cheese types with a relative short shelf-life have prevailed. Whereas in the mountainous area of Haute-Savoie the harder climate and more seasonal production created a need for large and hard cheeses with a longer storage time, and cheese like Comté became the dominant types [4].

Similar varieties in raw materials, environmental conditions and societal set-ups have resulted in the multiple and differentiated assortment of fermented food products that today accounts for 30% of the foods consumed by the world population [17]. The different geographical adaptations of fermentation processes show that, with global warming and climate changes, fermented foods can contribute to mitigate the new food challenges that Europe, but also the rest of the World, will meet going forward to 2050 and even longer.

3. Food Preservation by Fermentation

The most important ways to keep food fresh and safe are temperature (low or high), water activity, acidity (pH), redox potential, preservatives, competitive microorganisms, and their metabolites.

As an example EFSA writes in 2018 that Listeria monocytogenes is known to be negatively affected by the competitive growth of LAB, naturally present indigenous microbiota or added as starter cultures, [8]. If indigenous flora has an effect, why not take advantage of this by adding safe LAB cultures? The individual food matrices and their production conditions provide opportunities for selected microorganisms to prevail over others, whereby the dominant microorganisms exclude unwanted microorganisms from growing and can even eliminate these [3].

Certain LAB cultures have good ability to control the growth of yeast and molds in fermented products, thereby prolonging the shelf-life of the product and reducing food waste. Similarly other LAB cultures are qualified to inhibit the growth of pathogenic bacteria, e.g., *Listeria*, thereby securing safe food products such as in meat, fish, and ready-to-eat food products. The mechanisms involved in this biological preservation process are a combination of the following features in the cultures: 1) Competitive exclusion, 2) Competition for nutrients, and 3) Production of metabolites like organic acids and antimicrobials [2]. Competitive exclusion occurs when a culture occupies the available space in a food, thereby hindering growth of another unwanted micro-organism. As an illustration, a LAB culture can occupy the surface of lettuce, thereby hindering the presence of spoilage or harmful bacteria. Competition for nutrients is

happening when a culture depletes the food for a nutrient such as minerals [15], vitamins, sugar, or amino acids, with the result that the unwanted microorganism cannot use the essential compounds for its growth. The production of metabolites like organic acids (as acetic acid, lactic acid, propionic acid) can have a preservative effect by lowering the pH in the food product. Certain LAB cultures can produce the bacteriocin nisin, a peptide with inhibitory effect, but also other antimicrobial peptides can be produced from the proteins in the raw material.

All the three preservation elements or hurdles can be described as part of the mechanisms that microorganisms naturally possess for their survival in the microbial ecological system in foods. In a food context, the bioprotective effect of a LAB culture is therefore due to an optimal combination of the effect of all these hurdles, not just relying on one single hurdle [19].

4. The Economic Potential of Fermentation Technology to Limit Food Waste

According to the FAO [9], the food and agricultural industries account for approximately 1/3 of all Green House Gas emissions, and 8% of the global greenhouse emissions comes from food waste, which means that if food waste was a country, it would be the third biggest emitter of CO_2 [16]. A recent consumer research shows that consumers around the globe are increasingly concerned about this [11].

Fermentation-enabled protection can play a very relevant role in helping to keep even more food fresh and safe for longer [15]. Expiry date is cited as the reason for throwing away many kinds of food, and dairy products, fresh juices, chilled meat, and fish are among the top categories of food that are wasted most often [7].

From a consumer point of view, too short shelf life is the primary cause of avoidable food waste in yogurt [11]. 17% of all yogurts produced in the EU is wasted, and 80% of this is related to the date of expiration. An impact study showed how an additional 7-day shelf life could reduce yogurt waste with 30%, delivering 520,000 tons of CO_2 emission reduction and €250 million savings annually [18].

5. The EU Regulatory Framework for the Application of Fermentation in the Production of Foods

The EU regulatory framework falls behind the rising interest in the use of microorganisms in food, including but not limited to innovations in fermentation. All foods need to be safe. In some situations, evidence of safety must be provided in an authorization procedure. Food cultures may be subject to this requirement if they are genetically modified (as of 2021 there are none on the EU market) or if they classify as ingredients that do not have a history of safe use in the EU prior to 1997 and are therefore being considered as novel foods. As microorganisms are included in the Novel Food regulation, it is a salient fact that food cultures are food ingredients and therefore regulated under the General Food Law, article 14 of which states: "food shall not be placed on the market if it is unsafe" [12]. Despite this there are indications that certain uses of fermentation may even classify as (quasi) food additives and would for this reason be prohibited if not approved as food additives. The indication has been ongoing since 2006 when the Scientific Committee of the Food Chain and Animal Health (SCoFCAH) drafted four criteria for the use of microbial culture, including the criterion: "added near final stage for technological effect, e.g. preservation" that was classified as food additives. The criteria were not and have not been adopted by SCoFCAH. If this regulatory change is implemented, it will be a step back for the innovations for natural and sustainable foods.

6. Conclusion

For the application of the fermentation technology to secure bio-protection of foods the position of LABIP is:

The LAB industry in the EU finds that, applying fermentations by using LAB cultures in the production and preservation of foods, is to be considered a natural and integrated way for producing safe and sustainable foods. The potential that the same LAB culture species can belong to two different regulatory categories (food ingredient or food additive), depending on an uncertain time as "near final stage" of application is not a sensible and workable solution. The safety of the use of a LAB culture is not "stage dependent". A new requirement that an EU food additive approval is needed for one application stage when the same LAB culture has been used for food fermentation during centuries is not scientifically coherent. All applications of fermentation in the production of food must therefore continually be regulated as an ingredient under the auspices of the EU general food law. For further consumer transparency using LAB cultures with a protective effect in the production of foods could then be labeled as "Protected by fermentation". We believe this will end and close 16 years of discussion and uncertainty for the European food business and unleash the full potential of fermentation in helping to secure the green transition of the EU food system. Fermentation should remain part of the responsibility of the food business operator under the General Food Law Regulation. This will ensure the safety and proper labelling of any LAB culture ingredient used in food production.

Acknowledgements

The authors thanks LABIP for planning, inviting, and funding this Expert Workshop.

Speakers and participants in the LABIP Expert workshop on "Bio-preservation through fermentation, a natural and sustainable process – Opportunities, Risks and Regulation" held in Bruges, Belgium 27-28 September 2021: B. Martinez,

Ipla Csic, Spain – B. van der Meulen, European Institute for Food Law, University of Copenhagen, Danmark – C. Lacroix, ETH, Switzerland – C. Chassard, INRA, France – H. Bachmann, NIZO, The Netherlands – J. Hugenholtz, Wageningen Food & Biobased Research, The Netherlands – M. Callanan, Cork Institute of Technology, Irland – P. Thoeysen, Chr. Hansen, Denmark – J. Leech, Teagasc, Ireland. Participants from LABIP: B. Bogicevic, P. Boyaval, M. Brandt, S. Dashko, S. Duboux, J-M. Faurie, L. Gruson, I. Haagsma, M. Kuilman, P. Laforce, E. Laulund, S. Laulund, A. Ledeboer, S. Legrain, D. Lucena, A. Nauta, T. O'Sullivan, S. Pedersen, B. Pot, J. W. Sanders, A. Sourabie, M. Thybo.

References

[1] Ben-Harb, S., Saint-Eve, A., Panouillé, M., Souchon, I., Bonnarme, P., Dugat-Bony, E., Irlinger, F. (2019). Design of microbial consortia for the fermentation of pea-protein-enriched emulsions. Int J Food Microbiol 293: 124-136. https://doi.org/10.1016/j.ijfoodmicro.2019.01.012

[2] Ben Said, L., Gaudreau, H., Dallaire, L., Tessier, M., & Fliss, I. (2019). Bioprotective Culture: A New Generation of Food Additives for the Preservation of Food Quality and Safety. Industrial Biotechnology, June. 138-147. http://doi.org/10.1089/ind.2019.29175.lbs

[3] Bourdichon, F., Arias, E., Babuchowski, A., Bückle, A., Dal Bello, F., & Dubois, A. et al. (2021). The forgotten role of food cultures. FEMS Microbiology Letters, Vol. 368, No. 14 https://doi.org/10.1093/femsle/fnab085

[4] Chassard, C. Personal communication LABIP Expert Workshop, Bruges, 2021.

[5] European Commission (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Farm to Fork Strategy for a fair, healthy, and environmentally friendly food system. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0381

[6] European Commission DG Environment (2022). Chemical strategy. https://environment.ec.europa.eu/strategy/chemicals-strategy_en

[7] European Commission, Directorate-General for Health and Food Safety (2018). Market study on date marking and other information provided on food labels and food waste prevention: final report, Publications Office. https://data.europa.eu/doi/10.2875/808514

[8] EFSA Panel on Biological Hazards (BIOHAZ) (2018). Listeria monocytogenes contamination of ready-to-eat foods and the risk for human health in the EU. EFSA Journal 2018; 16 (1): 5134. doi: 10.2903/j.efsa.2018.5134.

[9] Food and Agriculture Organization of the United Nations, Global Food Losses and Food Waste. Extent, Causes and Prevention. (2011) https://www.fao.org/fileadmin/user_upload/suistainability/pdf/Global_Food_Losses_and_Food_Waste.pdf

[10] IDF (2019). Factsheet 7/2019 Bioprotection. https://shop.fil-idf.org/products/idf-factsheet-007-2019-bioprotection

[11] Kantar for Chr. Hansen (2019): Consumer Study conducted by Kantar Gallup for Chr. Hansen A/S.

[12] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January (2002) laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32002R0178

[13] Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December (2008) on food additives. https://eurex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:354:0016:0033:en:PDF

[14] Salque, M., Bogucki, PI., Pyzel, J., Sobkowiak-Tabaka, I., Grygiel, R., Szmyt, M., & Evershed, RP. (2013). Earliest evidence for cheese making in the sixth millennium BC in northern Europe. Nature 493, 522-525. doi: 10.1038/nature11698.

[15] Siedler, S., Holm Rau, M., Bidstrup, S., Vento, J. M., Dissing Aunsbjerg, S. & Bosma, E. F. et al. (2020). Competitive Exclusion Is a Major Bioprotective Mechanism of Lactobacilli against Fungal Spoilage in Fermented Milk Products. Appl Environ Microbiol 86: e02312-19. https://doi.org/10.1128/AEM.02312-19

[16] United Nations Environment Programme, Food Waste Index Report (2021). https://www.unep.org/resources/report/unep-food-waste-index-report-2021

[17] Vogel, RF., Hammes, WP., Habermeyer, M., Engel, KH., Knorr, D., & Eisenbrand, G. (2011). Microbial food cultures – opinion of the Senate. Commission on Food Safety (SKLM) of the German Research Foundation (DFG). Mol. Nutr. Food Res. 55, 654–662. DOI 10.1002/mnfr.201100010.

[18] Westergaard-Kabelmann, J. (2016). Qbis Consulting. Reducing food waste and losses in the fresh dairy supply chain; Chr. Hansen impact study. https://www.chr-hansen.com/en/food-cultures-and-enzymes/bioprotection/cards/reducing-food-waste-with-natures-own-resources

[19] Wiernasz, N., Cornet, J., Cardinal, M., Pilet, MF., Passerini, D., & Leroi, F. et al (2017) Lactic Acid Bacteria Selection for Biopreservation as Part of Hurdle Technology Approach Applied on Seafood. Frontiers in Marine Science 4, 1-15. doi: 10.3389/fmars.2017.00119.