Climate change is expected to increase food waste due to spoilage of non-refrigerated foods: Use of risk assessment to identify mitigation strategies



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Predictive Modelling Tools to Evaluate the Effects of Climate Change on Food Safety and Spoilage





Partners





11 European countries7 Academic Institutes6 Industry Partners1 United Nations Agency (FAO)



Ourania Misiou (AUTh, PhD candidate)



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Food Chain Environmental Sustainability Life Cycle Assessment

Integrated Decision Support System (DSS)



Quantitative Risk Assessment Chemical & biological hazards

Dynamics of Microbial Change Development of quantitative tools







Irrigation

Waste-water Impaired Quality









SCIENTIFIC OPINION



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Guidance on date marking and related food information: part 1 (date marking)

EFSA Panel on Biological Hazards (BIOHAZ), Konstantinos Koutsoumanis, Ana Allende, Avelino Alvarez-Ordóñez, Declan Bolton, Sara Bover-Cid, Marianne Chemaly, Robert Davies, Alessandra De Cesare, Lieve Herman, Maarten Nauta, Luisa Peixe, Giuseppe Ru, Marion Simmons, Panagiotis Skandamis, Elisabetta Suffredini, Liesbeth Jacxsens, Taran Skjerdal, Maria Teresa Da Silva Felicio, Michaela Hempen, Winy Messens and Roland Lindqvist

Food Spoilage





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- ToR 1: The factors that, from a microbiological point of view, make certain foods highly perishable and therefore likely after a short period to constitute an immediate danger to human health, and on how those factors should be considered by food business operators when deciding whether a 'use by' date is required and setting the shelf-life and the required storage conditions
- ToR 2: The factors that, from a microbiological point of view and limited to foods intended to be stored at controlled temperatures, make certain foods become unfit for human consumption, but still without constituting an immediate danger to human health, and on how those factors should be considered by food business operators when deciding whether a 'best before' date is appropriate and setting the shelf-life and the required storage conditions

Food Spoilage



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- Use-by date: for foods that at the end of shelf-life constitute 'an immediate danger to human health' or become 'injurious to health' due to growth of pathogenic microorganisms
- Best before date: for foods that at the end of shelf-life might become 'unfit for human consumption' due to growth of spoilage nonpathogenic microorganisms



Thermophilic **spore-forming** bacteria(*Bacillus* spp., *Geobacillus* spp., *Alicyclobacillus* spp., *Anoxybacillus* spp, *Paenibacillus* spp.)



The **microbiological stability** of non-refrigerated food products is based on the fact that **current conditions** of distribution and storage **do not allow extensive growth** of thermophilic bacilli due to their high minimum temperature for growth









Heat-processed non-refrigerated foods





Climate change-Objective



Projected temperature increase predictions between 1.4 και 4.4 (average 2.7 °C) by the end of the 21st century

Intergovernmental Panel on Climate Change, 2021

Temperature increase should not exceed 2°C by 2100

Paris Agreement, 2016



Modelling spoilage bacteria behaviour as an effect of climate change









Climate change & Food spoilage



Predicted growth of *Geobacillus stearothermophilus* in canned milk

> Temperature Athens 2015

Climate change scenario: Increase of 3 °C



Climate change & Risk of spoilage



Cummulative Probability

Fig. 2. Probability of *Geobacillus stearothermophilus* growth in canned milk during one year of storage in 38 European cities. A: Cumulative probability of *G. stearothermophilus* growth for the baseline scenario (BSc) and the 3 global warming scenarios (GWS) including increases in the mean surface temperature of 1.5 (GWSc-1), 3.0 (GWSc-2) and 4.5 (GWSc-3) °C. B: Probability of *G. stearothermophilus* growth exceeding the spoilage level (7 Log CFU/mL) with 1 and 2 Log CFU/mL intervals.



Climate change & Risk of spoilage





■ 50th Perc. ■ 90th Perc. ■ 95th Perc ■ 99th Perc.





Climate change & Risk of spoilage

failing to achieve the 2 °C target for climate change can lead to a very high risk of spoilage and cause a collapse of the shelfstable food chain

Food waste management scientific community is expected to be really busy the next years...







Mitigation Strategies: Impact of insulated storage





Non- insulated storage



Risk of spoilage (Probability)			
0	(10 ⁻⁶ -10 ⁻³)	(10 ⁻³ -10 ⁻¹)	(10 ⁻¹ -10 ⁻⁰)





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Climate change and its implications for food safety and spoilage

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ARTICLE INFO ABSTRACT Keywords Keywords: Most studies on the impact of climate change on foods focus on the consequences to security and safety. In the climate change Climate change present study we provide scientific evidence on an overlooked aspect of climate change related to the micro- Global warming Global warming biological stability of foods. Most microbiologically stable processed foods are contaminated with spores of Microorganisms Non-refrigerated foods thermophilic spoilage bacteria which are highly heat-resistant and can survive thermal processing. Current Food safety Food spoilage temperatures during distribution and storage in temperate climates do not allow growth of thermophilic bacteria Food quality Thermophilic bacteria to levels that can cause spoilage, ensuring their microbiological stability. Our findings suggest that the latter Food spoilage Risk of spoilage limiting condition can be eliminated by global warming. By assessing different global warming scenarios for 38 European cities in a case study with canned milk, we show that failing to limit the increase of global mean surface subsequently cause a collapse of the shelf-



ARTICLE INFO

ABSTRACT

Background: Climate change constitutes a complex challenge posing an urgent threat to our planet and life and creating an entirely different way of conceptualising the world and our chances to provide safe food within it. There are currently numerous studies dealing with the potential effect of increased temperature, extreme weather events and cascading events on food safety and subsequently human health. In contrast to food safety, the available data on the impact of climate change on food quality, including food spoilage, are very limited. Scope and approach: This paper presents an overview of the potential impact of climate change on both food safety and microbial spoilage at various stages of the food chain. Among the different hazards related to climate change, mycotoxin and marine biotoxin contamination, environmental residuals derived from various anthropogenic activities and zoonosis diseases are identified as climatic-driven emerging risks to human life and discussed further in this paper. Global warming is projected to affect all microorganisms, including spoilage bacteria and fungi. Hence, this paper also discusses the potential increased risk of microbial spoilage for bulk dried foods and non-refrigerated processed foods which could be high susceptible to climate change in relation to growth of spoilage organisms.



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THANK YOU Questions?

