VALIDATING LIGNIN-BASED ANTIOXIDANTS IN REAL FOOD MATRICES

ASINCAR's work in ZEBRA: testing lignin-derived antioxidant compounds in bakery and meat products

INTRODUCTION

Lipid oxidation remains a major challenge for the food industry, particularly in products containing fats and oils, where it can affect shelf life, sensory quality, and consumer acceptance. The validation of naturally derived antioxidant solutions is important for companies seeking sustainable ingredients without compromising stability or safety.

ABOUT ASINCAR

ASINCAR is a Spanish agri-food technology centre specialising in food technology, meat products, product development, shelf-life studies, microbiological validation, sensory evaluation, and applied R&D. As part of the **ZEBRA** project, ASINCAR evaluated whether the lignin-derived LMW compound produced by CENER could be incorporated into food products, analysing their technological behaviour, antioxidant capacity, and limitations.

WHAT WAS VALIDATED

The validation focused on the use of LMW compound as potential antioxidant ingredients in real food matrices. The study was conducted primarily using sunflower oil cookies and Asturian chorizo, selected because they represent different technological environments. The cookies provide a relatively straightforward model for evaluating lipid oxidation under thermal processing and accelerated storage, while Asturian chorizo is a more complex fermented and dried meat matrix, influenced by curing ingredients, spices, fermentation, drying, fat composition, and sensory attributes. A beef burger matrix was also considered in the initial stages, but it did not reach final validation due to unfavourable preliminary results.

HOW THE PROCESS WENT

The validation process combined formulation work, pilot-scale processing, storage studies, and analytical monitoring. LMW compound was incorporated into the selected matrices under controlled conditions and compared with reference formulations. The evaluation

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included the peroxide value and TBARS as indicators of oxidation, along with microbiological and sensory assessments where appropriate.

From a technological perspective, the compound could be incorporated without significant alterations to the manufacturing process. However, the observed antioxidant effect was limited and not entirely consistent across all validation conditions analysed. Some results suggested a protective effect against lipid oxidation, particularly regarding peroxide formation, but this behaviour was not robust enough to confirm reproducible antioxidant functionality at this stage.

The study also revealed that the complexity of the matrix is a key factor. In cookies, oxidative changes were easier to interpret, whereas in Asturian chorizo, the response was influenced by the interaction between formulation, curing, fermentation, drying, and sensory attributes. Sensory evaluation also indicated that increasing the dose did not necessarily improve performance and could negatively affect product acceptance.

Concurrently, a preliminary in vitro oral toxicity assessment was conducted using Caco-2 intestinal epithelial cells as a model of the human intestinal barrier. The study included parameters related to cytotoxicity and genotoxicity and provided an initial safety screening of the compound. These results constitute a first step in safety assessment but do not replace the comprehensive regulatory evaluation required prior to use in food.
The main barriers identified were the need to improve the consistency of antioxidant efficacy and better understand the interaction between LMW compound and complex food systems.

"This milestone has allowed us to evaluate the actual behaviour of lignin-derived antioxidant compounds in complex food matrices. The results demonstrate the technological feasibility, but they also highlight the need to continue optimising them before considering their use in food products."

Sergio Serrano, Project Technician, ASINCAR.

NEXT STEPS

Further work would be required before considering commercial application. The main priorities are to improve batch reproducibility, confirm antioxidant efficacy under industrial processing and storage conditions, and better understand the interaction between LMW compounds and complex food systems. From a regulatory perspective, additional safety, toxicological and legal assessment would also be needed to support any future use as a food additive or functional antioxidant ingredient.

Commercialisation should only be considered once technological efficacy, sensory compatibility, regulatory feasibility and safety requirements are addressed.

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