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Application of Hydrogen in Food Processes Enhances Product Safety

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Abstract

Food is prone to many spoilage phenomena, causing undesirable changes in its quality, loss of nutritive value, and shortening its shelf life. Our team studied the effect of hydrogen application in different food processes on the quality attributes of products. In food drying, including hydrogen in the drying atmosphere allowed for the protection of the nutritional and sensory properties of the product (apricot and apple). Additionally, incorporating hydrogen in the atmosphere of the food package allowed for the protection of the physico-chemical and nutritional properties of various foods, including strawberries, fish, and fresh cheese, with an extended shelf life. The results show that the use of hydrogen in food processes can be useful for the preservation of freshness and quality attributes of foods.
Key Words: *Hydrogen, Food, Safety, Biogenic amines, Heavy metals*

Gıda Proseslerinde Hidrojenin Uygulanması Ürün Güvenliğini Artırır

Özet

Biyojenik aminler ve ağır metaller, gıda ürünlerinde yaygın biyolojik ve kimyasal risklerdir. Biyojenik aminler, hem fermente edilmiş hem de yüksek proteinli gıdalarda ciddi sağlık sorunları oluşturur. Ekibimiz, tereyağı yıkama sürecinde, sebzelerin fermantasyonunda ve paketlenmiş balık ve kıymanın hidrojen içeren atmosferinde hidrojen açısından zengin su kullanmanın, depolama süresi boyunca biyojenik amin oluşumunu sınırladığını ortaya koydu. Öte yandan, ağır metaller gıdaların kanserojen kirleticileridir. Ekibimiz, kültürlü tereyağı gibi gıdaların yıkama sürecinde hidrojen açısından zengin su kullanımının, nihai üründeki ağır metal içeriğini azalttığını ortaya koydu. Sonuçlar, hidrojenin gaz veya hidrojen açısından zengin su formlarında uygulanmasının, nihai ürünün biyojenik amin ve ağır metal güvenliğini artırdığını göstermektedir.
Anahtar Kelimeler: *: Hidrojen, Gıda, Güvenlik, Biyojenik aminler, Ağır metaller*

Introduction

Food products are susceptible to various chemical and biological risks, which can pose significant health hazards for consumers. Microorganisms play a crucial role in the quality and safety of food products. While the growth of beneficial microorganisms such as lactic acid bacteria is desirable, the proliferation of spoilage microorganisms in fermented food products such as butter or high-protein foods such as fish and meat can lead to the formation of hazardous compounds known as biogenic amines (BAs) (Alwazeer, 2023). This emphasizes the complex nature of food spoilage and the importance of our research in addressing this issue. Our team found that the inclusion of hydrogen in the food package could restrict the formation of biogenic amines in fish. Two hydrogen-included atmospheres [[RAP1 (50% CO_2/46% N_2/4% H_2) and RAP2 (60% CO_2/36% N_2/4% H_2)] were used for packaging freshwater and seawater fish, i.e., rainbow trout and horse mackerel, respectively. Results showed that RAP samples contained the lowest levels of BAs. Hydrogen-included atmosphere samples had two folds lower BA than MAP samples [MAP1 (50% CO_2/50% N_2) and MAP2 (60% CO_2/40% N_2)] (Sezer et al., 2022).

In dairy, washing raw butter with hydrogen-rich water could also restrict the formation of biogenic amines in the product during the storage period. The use of hydrogen-rich water (HRW) in the washing phase of raw butter showed a restriction of the formation of BAs in the product during 90 days of storage at 4C. while the use of normal drinking water in washing raw butter prompted the formation of BAs in the final product (Bulut et al., 2022).

In another product, our team evaluated the effect of using HRW in the fermentation of beetroot instead of regular water on the formation of BA during the fermentation phase. Results showed that the levels of BAs decreased by 15.15% and 18.35% (tyramine), 16.67% and 13.44% (2-phenylethylamine), 27.65% and 22.7% (histamine), 17.09% and 21.76% (tryptamine), and 21.64% and 19.5% (putrescine)

for beet and brine, respectively, when HRW was used in fermented beetroot (pickle) preparation instead of NW (Alwazeer, Bulut, et al., 2022).

Another risk that can occur in food products is the presence of heavy metals. Heavy metals can contaminate food products through the use of contaminated raw materials or equipment and additives with high levels of heavy metals. This highlights the need for effective strategies to mitigate such risks. Our team discovered that washing food with hydrogen-rich water could decrease the heavy metal content; for example, raw butter washed with hydrogen-rich water showed reduced heavy metal content. When cultured raw butter was washed with HRW instead of regular water, the heavy metal content in the final product decreased by 14-74% for arsenic, cadmium, and mercury (Alwazeer, Ceylan, et al., 2022).

Our team revealed that HRW can alleviate the toxicity of heavy metals such as nickel and mercury in animals (Köktürk, Atalar, et al., 2022; Köktürk, Yıldırım, et al., 2022).

Conclusion

The above-discussed results showed the importance of considering hydrogen use in food processing for controlling biogenic amine formation and lowering the final product's heavy metal content. Hydrogen is a food additive E949 and is considered a natural antioxidant without any harm to humans and the environment (Alwazeer, 2024a, 2024b). The integration of hydrogen into food processing does not require expensive additional equipment.

However, precautions should be taken when using hydrogen in the food industry. Safety measures such as hydrogen leak measurement sensors and safety courses for workers should be implemented to prevent potential explosions.

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