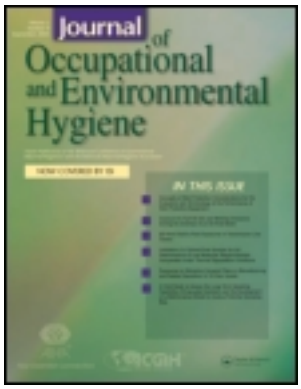


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# Identification of Diacetyl Substitutes at a Microwave Popcorn Production Plant

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# Case Study
# Identification of Diacetyl Substitutes at a Microwave Popcorn Production Plant

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## INTRODUCTION

Diacetyl (2,3-butanedione) is a volatile diketone commercially synthesized and used to make butter flavoring for food production. It also is a naturally occurring product of fermentation and is found in butter, wine, and coffee. Diacetyl was first recognized as a respiratory health hazard at a microwave popcorn production plant.[1–3] The inhalation of butter flavorings containing diacetyl can cause severe shortness of breath and cough in workers exposed during microwave popcorn manufacturing. These symptoms may result from a rare, disabling lung disease called bronchiolitis obliterans, which has caused death or the need for lung transplant in some exposed microwave popcorn workers. Bronchiolitis obliterans has also been identified in flavoring and diacetyl manufacturing workers.[4,5] Accordingly, flavor manufacturers have started to substitute other chemicals for diacetyl in butter flavorings, including chemically similar diketones.

## BACKGROUND

One substitute, 2,3-pentanedione, in initial toxicity testing was comparable to diacetyl in causing epithelial injury.[6,7] Most other substitutes have not been tested in animals for airway damage. Food manufacturers may be unaware of the diacetyl substitutes being used in artificial butter flavorings purchased from flavoring producers, as in a recent investigation of a dry bakery mix plant.[8] A microwave popcorn production plant asked NIOSH to evaluate chemical constituents in their eight butter flavorings. Their flavoring supplier informed them that substitutes for diacetyl were being used in the formulations, but they were not told what these chemical substitutes were. NIOSH collected the liquid bulk butter flavoring samples at the plant and conducted a quantitative gas chromatography/mass spectrometry (GC/MS) analysis and a semi-quantitative headspace analysis using a thermal desorption tube technique on the samples.

## RESULTS

Quantitative GC/MS analysis showed acetoin in five of the eight butter flavoring samples; 2,3-pentanedione in four; and 2,3-hexanedione in one. Diacetyl and 2,3-heptanedione were not detected in any sample. Concentrations of chemicals were 0.5% or less by weight, with the exception of one sample having a level of 2% by weight of acetoin. The more sensitive semi-quantitative method detected acetoin and diacetyl in all eight samples; 2,3-pentanedione in five; 2,3-hexanedione in one; and 2,3-heptanedione in one. The compounds detected with the semi-quantitative method were found in relative abundance similar to those found in the quantitative analyses; diacetyl was almost always the smallest of the abundance peaks in each sample. Of

the compounds found, only acetoin was listed on the Material Safety Data Sheets (MSDS) for the products, and only on four of the eight.

## CONCLUSIONS

Companies need to be aware that the substitute diketones used in the butter flavors are unlikely to be safer than diacetyl. No federal regulations exist yet to control exposures to these flavor chemicals in workplaces. The same precautions for preventing diacetyl exposures are likely necessary for 2,3-pentanedione and other butter flavoring substitutes, both for exposure reduction and medical surveillance.[6–9] In discussions with flavor suppliers, it would be important to request semi-quantitative information on ketone ingredients including diketones such as 2,3-pentanedione. The inclusion of this information on MSDSs is needed to ensure that management and workers have information that would motivate and guide exposure control including compliance with respiratory protection and source control.

## RESOURCES

Health hazard evaluations, technical documents, exposure control guidance, and additional resources can be found on the "NIOSH Flavorings-Related Lung Disease" topic page: http://www.cdc.gov/niosh/topics/flavorings/.



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