4-15-2019

Detection of Acrylamide in Food Using Near Infrared Spectroscopy

Mark Skinner
Boise State University

Maranda Cantrell
Boise State University

Owen M. McDougal
Boise State University

Detection of Acrylamide in Food Using Near Infrared Spectroscopy

Abstract

Acrylamide is a suspected carcinogen required to be listed on food labels in California and products commercially traded within the European Union. Foods like potato products, coffee, crackers, etc., are produced at elevated temperatures, which provide conditions that convert the amino acids, Asn, *Arg* and *Lys*, in combination with reducing sugars, into acrylamide via the Maillard reaction. Current methods to detect and quantitate acrylamide in food are costly, time consuming, and dependent on expensive scientific instrumentation (i.e., Liquid Chromatography-Mass Spectrometry (LC-MS)). Near Infrared (NIR) spectroscopy is inexpensive, fast, easy to use, and applicable to acrylamide detection. The purpose of this study is to establish a standard method for quantitative detection of acrylamide in food using NIR spectroscopy. Acrylamide extractions from potato products will be monitored by NIR and the results validated using LC-MS. A standard acrylamide curve, in solution with a *coefficient of determination* (R^2) value of 0.966 and a standard curve in solid matrix with an R^2 value of 0.914 was established. A standard matrix spike will be obtained from acrylamide content measured in actual coffee and potato products to determine acrylamide content using NIR coupled with Partial Least Squares computational software. The NIR method will provide a fast and economical alternative to traditional food safety and security industry standards.

Detection of Acrylamide in Food Using Near Infrared Spectroscopy

Mark Skinner, Maranda Cantrell, Owen M. McDougal, Ph.D.
Department of Chemistry and Biochemistry, Boise State University

BOISE STATE UNIVERSITY

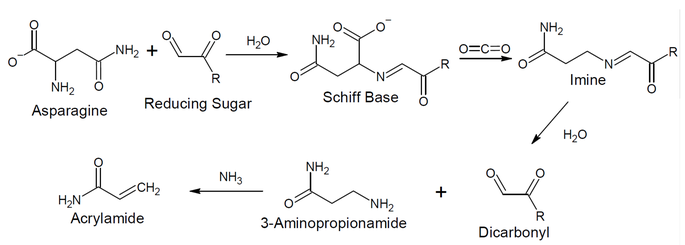
IDAHO STATE DEPARTMENT OF AGRICULTURE

Abstract

Acrylamide is a suspected carcinogen required to be listed on food labels in California and products commercially traded within the European Union. Acrylamide occurs at trace levels in foods like potato products, coffee, crackers, etc., when the Maillard reaction chemically alters amino acids, including Asn, Arg and Lys, and reducing sugars. Current methods to detect and quantitate acrylamide in food are costly, time consuming, and dependent on expensive scientific instrumentation (i.e., Liquid Chromatography-Mass Spectrometry (LC-MS)). Near Infrared (NIR) spectroscopy is inexpensive, fast, easy to use, and applicable to acrylamide detection. The purpose of this study is to establish a standard method for quantitative detection of acrylamide in food using NIR spectroscopy. Acrylamide extractions from potato products will be monitored by NIR and the results validated using LC-MS. A standard acrylamide curve, in solution with a coefficient of determination (R2) value of 0.966 was established and a standard curve in solid matrix will be made. Acrylamide content will be measured from actual coffee and potato products using NIR coupled with Partial Least Squares computational software and a standard curve. This method will contribute to food safety, security, and competitiveness within European and U.S. markets.

Introduction

Acrylamide is formed under conditions where temperatures exceed 120 °C in foodstuffs and tobacco products containing asparagine and reducing sugars. The *Maillard reaction* is responsible for acrylamide production (Scheme 1).



Background

In 1986, California residents voted to accept the *Safe Drinking Water and Toxic Enforcement Act,* Proposition 65.

In February 2011, acrylamide was added to the Prop 65 list of chemicals known to cause cancer, birth defects or reproductive harm.

On May 7, 2018 a California judge ruled acrylamide be added to the list of ~900 chemicals which companies must label the presence of, if present in products.

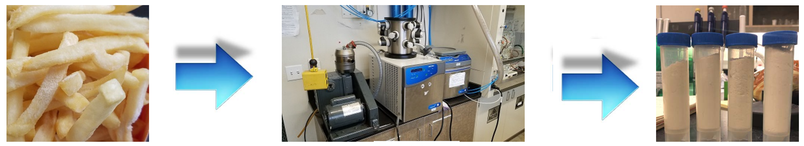
Studies conducted in 1986 and 1995 concluded acrylamide to be carcinogenic in rats and mice but acrylamide has not yet been proven as a carcinogen for humans. In fact acrylamide concentrations required to be carcinogenic in mice and rats were so high that humans would not likely match these daily concentrations in their normal diet.

Since California has the sixth largest economy in the world, many companies try to comply with Prop. 65 guidelines. The potential for companies worldwide to comply with these regulations is high.

Current methods to quantitate concentrations of acrylamide are HPLC and GC-MS. Both methods are complicated and require significant training and skill to perform.

Near Infrared spectroscopy is simple, rapid and can be performed with minimal preparation and training.

Methods

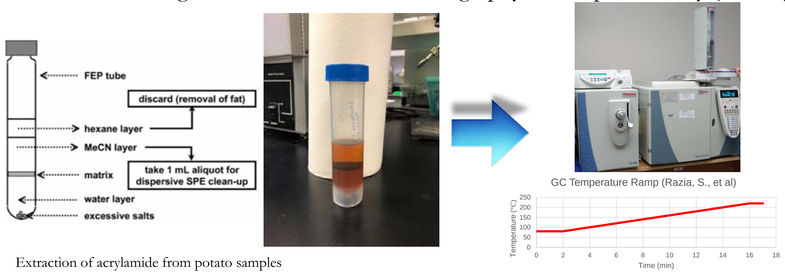


Acrylamide content will be analyzed using near infrared spectroscopy by serial dilution at concentrations of 0, 50, 100, 200, 400, 1000, 2000, 4000, 6000 and 8000 $\frac{\mu g}{L}$ acrylamide standard added to a homogeneous sample of unheated potato flour.

Partial-least-squares computational software will form a standard curve from these ten individual spectra.

A standard addition curve will be used in a similar manner to detect unknown acrylamide content in cooked potato products.

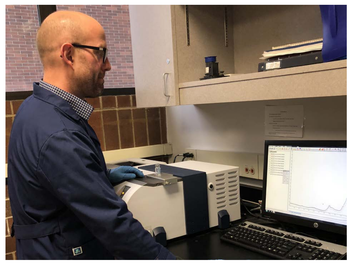
This method is being verified With Gas Chromatography-Mass Spectrometry (GCMS)

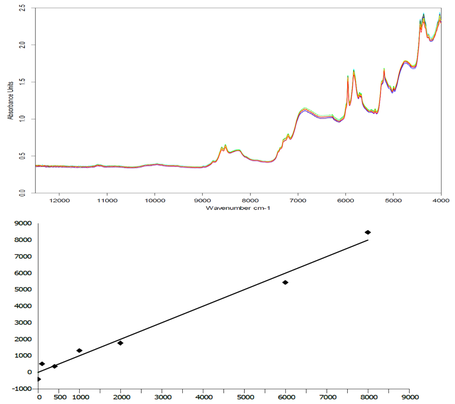


Extraction of acrylamide from potato samples

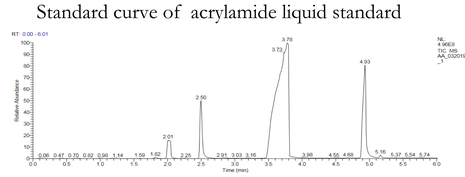
Results

IR spectrum of cooked fries. Colors denote the varying standard concentration as described in the methods.





Partial least squares computational software converts spectral overlay to a linear standard curve representation. Acrylamide content in cooked products can be quantitated with a standard addition curve.



Gas Chromatogram of derivatized Acrylamide Standard

Preliminary results look great so future plans will be to proceed with further analysis

References:

1. https://oehha.ca.gov/proposition-65/general-info/acrylamide accessed
2. Adedipe, O. E., et al (2017). MCJ 1851-1854
3. Razia, S., et al (2016). IFRJ 23(5), 2188-2189
4. Surma, M., et al (2016). JAFC 131, 99-100
5. Mastovska, K et al (2006). JAFC