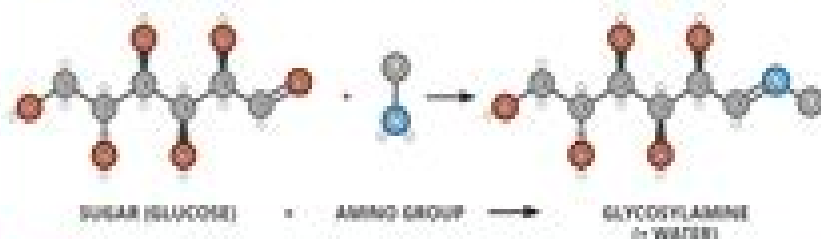


# A GUIDE TO THE MAILLARD REACTION

The Maillard reaction occurs during cooking, and it is responsible for the non-enzymatic browning of foods when cooked. It actually consists of a number of reactions, and can occur at room temperature, but is optimal between 140-165°C. The Maillard reaction occurs in three stages, detailed here.

1

The carbonyl group on a sugar reacts with a protein or amino acid's amino group, producing an N-substituted glycosylamine.



2

The glycosylamine compound generated in the first step isomerises, by undergoing Amadori rearrangement, to give a ketosamine.



3

The ketosamine can react in a number of ways to produce a range of different products, which themselves can react further.



## Classes of Maillard Reaction Products



The Maillard reaction produces hundreds of products; a small subset of these contribute to flavour and aroma, some groups of which are described below. Melanoidins are also formed; brown, polymeric substances which contribute to the colouration of many cooked foods.



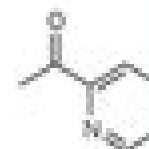
PIRAZINES  
cooked  
roasted  
toasted



PYRROLES  
cereal-like  
nutty



ALKYLPYRIDINES  
bitter  
burnt  
astringent



ACETYPYRIDINES  
crackling-like  
cereal



FURANONES  
sweet  
caramel  
burnt



FURANS  
meaty  
burnt  
caramel-like



OXAZOLES  
green  
nutty  
sweet



THIOPHENES  
meaty  
roasted

# Maillard Reaction

**Ian Pickup**



## **Maillard Reaction:**

Maillard Reaction Merlin C Thomas, Josephine Forbes, 2010-09-24 In September 2009 a meeting was held in Palm Cove Australia which brought together the world experts in the Maillard or browning reaction This reaction causes the browning of foods when they are heated and in chocolate caramel and beer this reaction is appetizing contributing to aroma taste and texture But when these products accumulate in the body this same process contributes to disease and ageing The book is the proceedings of that meeting held in response to a growing recognition of the role reactive carbonyl compounds play in food technology nutrition and tissue ageing in biology and medicine Reactive carbonyls now touch every aspect of food science biology and medicine Efforts to counteract the damage caused by these products are gaining acceptance as a basis for novel therapeutic approaches and the fields of food technology ageing and preventive medicine are experiencing an upsurge of interest in strategies to minimize the unwanted effects of the Maillard reaction The meeting also fostered a balanced approach to understanding both the advantageous and deleterious properties of carbonyl compounds and their end products in food science technology and medicine The major audience of this book is the large body of scientists and worldwide industries with an interest in the Maillard reaction in foods and biology and medicine with both basic and applied researchers and industry representatives from diverse fields who have interests in Chemistry of the Maillard Reaction Biology and the Maillard Reaction Enzymology Receptors and Signal Transduction Bioinformatics and Systems Biology Physiology Disease and Therapeutics Food Science and Nutrition and the Maillard Reaction

### **Chemistry of Maillard Reactions in**

**Processed Foods** Salvatore Parisi, Weihui Luo, 2018-06-29 This SpringerBrief explains the importance of Maillard reactions in food processing It underlines that the term Maillard reaction actually does not describe one single chemical reaction but an entire class of chemical reactions which lead to browning with a strong impact on visual appearance odor and flavor It emphasizes that the Maillard reactions are still not fully characterized despite extensive historical studies While under the right conditions Maillard reactions have many favorable effects e g formation of antioxidants the Brief discusses that there are also conditions where Maillard reactions can result in toxic or mutagenic reactions Hence it emphasizes that the reaction should be viewed as a complex network of various sub reactions with a plethora of concomitant reaction mechanisms and kinetics This Brief thus makes a step toward a holistic evaluation of the complexity of the Maillard reaction scheme with the aim of making better and more targeted use in food processing

### **Maillard Reactions in Food** C. Eriksson, 1981

Maillard Reaction Sian E Fayle, Juliet A Gerrard, 2007-10-31 It is almost 100 years since the Maillard reaction was first described Despite decades of research since then the products of the reaction and the mechanistic pathways leading to their formation are only gradually being unravelled Combining comprehensive information regarding the various methods that can be employed in the analysis of Maillard products with a discussion of the advantages and limitations of those methods this unique book provides a one stop text from which methods of analysis may be obtained It will be useful for both new and

experienced researchers who are involved in solving the mysteries and complexities of Maillard chemistry The Maillard Reaction in Food Chemistry Dongliang Ruan,Hui Wang,Faliang Cheng,2018-11-27 This book is devoted to the characterization of Maillard reaction products using mass spectrometry MS based technologies The Maillard reaction is a well known non enzymatic reaction between reducing sugars and proteins and one of the most important reactions in food sciences The authors explore different MS based technologies to systematically investigate the Maillard reaction from amino acids peptides and proteins By using amino acid peptide sugar models the authors also show how reactants temperature and time affect the Maillard reaction In this book readers will learn more about glucosylation and how it can improve functional properties of food proteins **Maillard Reaction** H E Nursten,2007-10-31 Research in the field of the Maillard reaction has developed rapidly in recent years as a result of not only the application of improved analytical techniques but also of the realisation that the Maillard reaction plays an important role in some human diseases and in the ageing process The Maillard Reaction Chemistry Biochemistry and Implications provides a comprehensive treatise on the Maillard reaction This single author volume covers all aspects of the Maillard reaction in a uniform co ordinated and up to date manner The book encompasses the chemistry of non enzymic browning recent advances colour formation in non enzymic browning flavour and off flavour formation in non enzymic browning toxicological aspects nutritional aspects other physiological aspects other consequences of technological significance implications for other fields non enzymic browning due mainly to ascorbic acid caramelisation inhibition of non enzymic browning in foods and inhibition of the Maillard reaction in vivo The Maillard Reaction Chemistry Biochemistry and Implications will be welcomed as an important publication for both new and experienced researchers who are involved in solving the mysteries and complexities of Maillard chemistry and biochemistry It will also appeal to students university lecturers and researchers in a variety of fields including food science nutrition biochemistry medicine pharmacology toxicology and soil science **Making Good Food Great** John Griffin,Jeff Gold,2017-08-18 There is a lot of good food There is not a lot of great There are reasons why some food is only just good and some food is just plain great Umami and the Maillard Reaction are two reasons why a dish will make the leap from good to great In this book Chefs Griffin and Gold demonstrate the nuances of technique and flavors that transform a simple dish that is just good to a simple dish that is just plain great With culinary illustrations by Elliott Wennet and many fine recipes Making Good Food Great will help you understand why some of your dishes taste great and help you improve all of your recipes *Maillard Reactions in Chemistry, Food and Health* T P Labuza,V Monnier,J Baynes,J O'Brien,1998-01-01 The Maillard reaction was originally studied due to its importance in foods Lately it has been found to play a key role in many health related issues It is now associated with diabetes ageing and cancer The 5th International Symposium on The Maillard Reaction was held at the University of Minnesota USA in August 1993 This volume of conference proceedings presents recent research and discusses aspects of the chemistry kinetics technology and toxicology of this reaction *The Maillard Reaction*

in *Foods and Medicine* John O'Brien, 1998 This collection of papers are devoted to a single chemical reaction the Maillard reaction They look at various different topics such as its use in the food industry and its relation to ageing and age related diseases This collection of papers are devoted to a single chemical reaction the Maillard reaction They look at various different topics such as its use in the food industry and its relation to ageing and age related diseases

**Maillard Reaction in Foods** Salvatore Parisi, Sara M. Ameen, Shana Montalto, Anna Santangelo, 2019-06-01 This book provides an overview of mitigation strategies and positive health effects of Maillard Reaction products in the contexts of food processing and storage The effects of Maillard Reactions can vary considerably while on the one hand certain sensorial alterations and influences on color flavor and odor may be desirable Maillard Reactions can also result in potentially harmful and toxic products e.g. furfurals furosines or acrylamide This book discusses possible mitigation strategies for the reduction of toxic reaction products including the addition of enzymes or antioxidants reducing sugars and encapsulation approaches as well as new processing strategies such as high pressure radio frequency ultrahigh temperature or Ohmic heating methods The book also illustrates that certain Maillard products can even produce positive health effects e.g. antimicrobial or anticarcinogenic effects The methods described here can serve as a blueprint for promoting the formation of beneficial compounds and reducing avoiding toxic substances offering essential strategies and methods

*The Maillard Reaction* Raphael Ikan, 1996-08-06 This first comprehensive review of the Maillard reaction and its applications shows the present state of the art including the most recent developments in its use Describing the relevance of the reaction in areas of chemistry geochemistry nutritional and life sciences leading scientists bring together both theoretical and practical aspects of the Maillard reaction

The Maillard Reaction in Foods and Nutrition George R. Waller, Milton S. Feather, 1983

The Maillard Reaction in Foods and Nutrition George R. Waller, 1983 Abstract Various aspects of the Maillard reaction a non enzymatic reaction that gives food its flavor and color during frying roasting and baking are discussed for food scientists and nutritionists in 29 technical papers The papers are organized into 7 sections covering historical development chemical aspects 6 papers flavors tastes and odors of cooked foods 6 papers food technology aspects 3 papers nutritional aspects with emphasis on lysine losses 6 papers in vivo Maillard reactions 2 papers and toxicological aspects with emphasis on mutagen production 5 papers A literature review of the sensory properties of almost 450 Maillard reaction products is included

**The Maillard Reaction** John W. Baynes, Vincent M. Monnier, Jennifer M. Ames, Suzanne Thorpe, 2005-08-12 The Maillard reaction first described during the early 20th century originally referred to the browning reaction that occurs between amino acids and sugars during the cooking and processing of foods This reaction contributes to the color taste aroma and texture of foods and also affects their nutritional and toxicological properties The Maillard reaction which has been at the crossroads of food and biomedical sciences is now also known to contribute to the natural and normal aging of tissue proteins and other biomolecules It is also implicated in the pathologic processes of a range of age related chronic

diseases including arthritis atherosclerosis diabetes and neurodegenerative diseases The role of the Maillard reaction in diabetes and its complications has become a major focus of research leading to a better understanding of the importance of oxidative stress lipid peroxidation and hyperlipidemia in diabetic complications This volume addresses all of these issues from food to biomedical sciences and highlights current research trends including the identification of new biomarkers nutrition and toxicology and the role of oxidative stress advanced glycoxidation and lipoxidation end products AGE ALEs in aging and chronic disease The last section of the book devoted to recent research on AGE ALE inhibitors in animal models and clinical trials assesses the current status of pharmaceutical interventions for retarding the Maillard reaction and the pathophysiology associated with aging and age related disease NOTE Annals volumes are available for sale as individual books or as a journal For information on institutional journal subscriptions please visit [www.blackwellpublishing.com/nyas](http://www.blackwellpublishing.com/nyas) ACADEMY MEMBERS Please contact the New York Academy of Sciences directly to place your order [www.nyas.org](http://www.nyas.org) Members of the New York Academy of Science receive full text access to the Annals online and discounts on print volumes Please visit <http://www.nyas.org/MemberCenter/Join.aspx> for more information about becoming a member

**The Maillard Reaction Reconsidered** Jack N. Lusso, 2016-04-19 Cooking involves chemical reactions that can make food smell and taste better However the same process that is responsible for creating the aroma flavor palatability color and taste of grilled and seared foods has also been linked to the development of chronic degenerative diseases The Maillard reaction produces advanced glycation end products

**The Maillard Reaction** Danica Slavica Crnčević, 2018 In 1912 Louis Camille Maillard a French physician and chemist accidentally discovered the formation of yellow brown color compounds when he heated sugars and amino acids together with water or the Maillard reaction Since then Maillard reaction has received wide attention and has been extensively studied in the fields of food and medicine The authors open this collection by discussing several factors that influence the Maillard reaction highlighting its recently discovered functional properties The origin of life on our planet is one of the issues that are on the top of biological agenda As such the authors propose that the abiogenic synthesis of prebiotic molecules could have taken place as early as in the interstellar gas dust clouds since several organic compounds including formaldehyde and other aldehydes as well as ketones were identified in space In conclusion two studies on the Maillard reaction of the glucose asparagine physical mixture and ribose albumin film are introduced by the use of a unique differential scanning calorimetry and Fourier transform infrared combined technique This technique can not only induce and accelerate the Maillard reaction but can also detect continuous pathways and intermediates of the Maillard reaction

*The Maillard Reaction* John W. Baynes, 2005 The role of the Maillard reaction in diabetes and its complications has led to a better understanding of the importance of oxidative stress lipid peroxidation and hyperlipidemia in diabetic complications This volume addresses all of these issues and highlights current research trends

**Postharvest Technology of Fruits and Vegetables: General concepts and principles** L. R. Verma, V. K. Joshi, 2000 This book covers various methods of extending

the postharvest life of fruits and vegetables viz storage packaging canning chemical low temperatures preservation irradiation fermentation waste management      **Handbook of Food Preservation** M. Shafiur Rahman, 2007-07-16 The processing of food is no longer simple or straightforward but is now a highly interdisciplinary science A number of new techniques have developed to extend shelf life minimize risk protect the environment and improve functional sensory and nutritional properties The ever increasing number of food products and preservation techniques cr      The Maillard Reaction in Food Processing, Human Nutrition and Physiology P. Finot, 1990-03

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