International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Maillard Reaction Pathway

Heena kauser [1], Parwez Ali*[2],Shivli Jha*[3], V. Sri Teja*[4]

[1] M. Tech Scholar, Dept. of Dairy chemistry, DSC, KVAFSU, Bengaluru, Karnataka, India
[2] M. Tech Scholar, Dept. of Dairy Technology, DSC, KVAFSU, Bengaluru, Karnataka, India
[3] M. Tech Scholar, Dept. of Dairy chemistry, SRS-NDRI,Bengaluru, Karnataka, India
[4] Phd. Scholar, Dept. of Dairy Technology, DSC, KVAFSU, Bengaluru, Karnataka, India

ABSTRACT

Nonenzymatic browning is a process in which sugars and proteins react chemically to make food more appealing. Ascorbic acid degradation, lipid peroxidation, the caramel reaction, and the Maillard reaction are examples of non-enzymatic browning reactions. Milk protein and lactose, being two of the most important components of milk, have strong chemical activity and are used as reactants in the Maillard process, resulting in Maillard reaction products (MRPs). In the Maillard reaction, a condensation process occurs between carbonyl groups of different sugars and amino groups of amino acids or proteins in the maillard reaction. These Maillard reaction products have a variety of uses, including food flavour, antioxidant properties for example. The beneficial and negative effects of the Maillard reaction are based on the two primary components of milk that are employed in food andpharmaceutical , as well as ways to avoid unfavourable consequences.

Key words – Maillard, nonenzymatic browning,Maillard reaction products

I.INTRODUCTION

In 1912, Louis Camille Maillard was the first to discover the Maillard reaction. It refers to the reaction between reducing sugars and proteins that occurs without the use of enzymes [1]. In the food processing industry, the Maillard reaction is also known as glycosylation. Maillard reaction products are typical food additives that can enhance the appearance and flavour of food. The Maillard reaction, on the other hand, has several negative side effects, the most visible of which may be seen in food and pharmaceuticals. Many studies now show that the Maillard reaction occurs.Dietary product consumption has been linked to a number of illnesses [2].In the pharmaceutical industry;Maillard reaction will cause problems during the manufacturing process and with product quality, such as colour changes, pharmaceutical bioavailability, active substance degradation, hazardous chemicals, and so on [3].

II.LITERATURE REVIEW

The Maillard reaction (Figure 1), also known as the non-enzymatic browning reaction, is a complex chain of non-enzymatic reactions that can be divided in three steps [4]. Figure 1 shows a modified diagram of the three steps of the Maillard reaction [4, 5].

Glycation of proteins is usually thought to be the first step in the Maillard process. The condensation reaction between the carbonyl groups of reducing carbohydrates and the ε-amino groups of lysine or to a lesser extent, between the α-amino groups of terminal amino acids and the imidazole and indole groups of histidine and tryptophan, respectively, is the first reaction of the initial stage [6]. The non-protonated amino group is first added to the reducing sugar electrophilic carbonyl carbon. The imine formed as a result of this addition is dehydrated, giving rise to the Schiff base [6]. The Schiff base is thermodynamically unstable, and it spontaneously rearranges to a 1,2-aminoenol, which then irreversibly rearranges to the more stable 1-amino-1-deoxy-2-ketose/aminoketose, also known as the Amadori product [6].

When ketoses such as fructose are used instead of aldoses, N-ketosylamines (1,2 amino enols) are transformed into 2-amino-2-deoxyaldoses, commonly known as the Heyns product [7]. The degradation of the Amadori/Heyns compounds begins the intermediate stage of the Maillard reaction. Dehydration and fission, mostly by dealdolization and Strecker degradation, the interaction of amino acids with dicarbonyl compounds, are part of this stage. They undergo 1,2-enolization at neutral or acidic pH, resulting in furfural or hydroxymethylfurfural production (HMF).

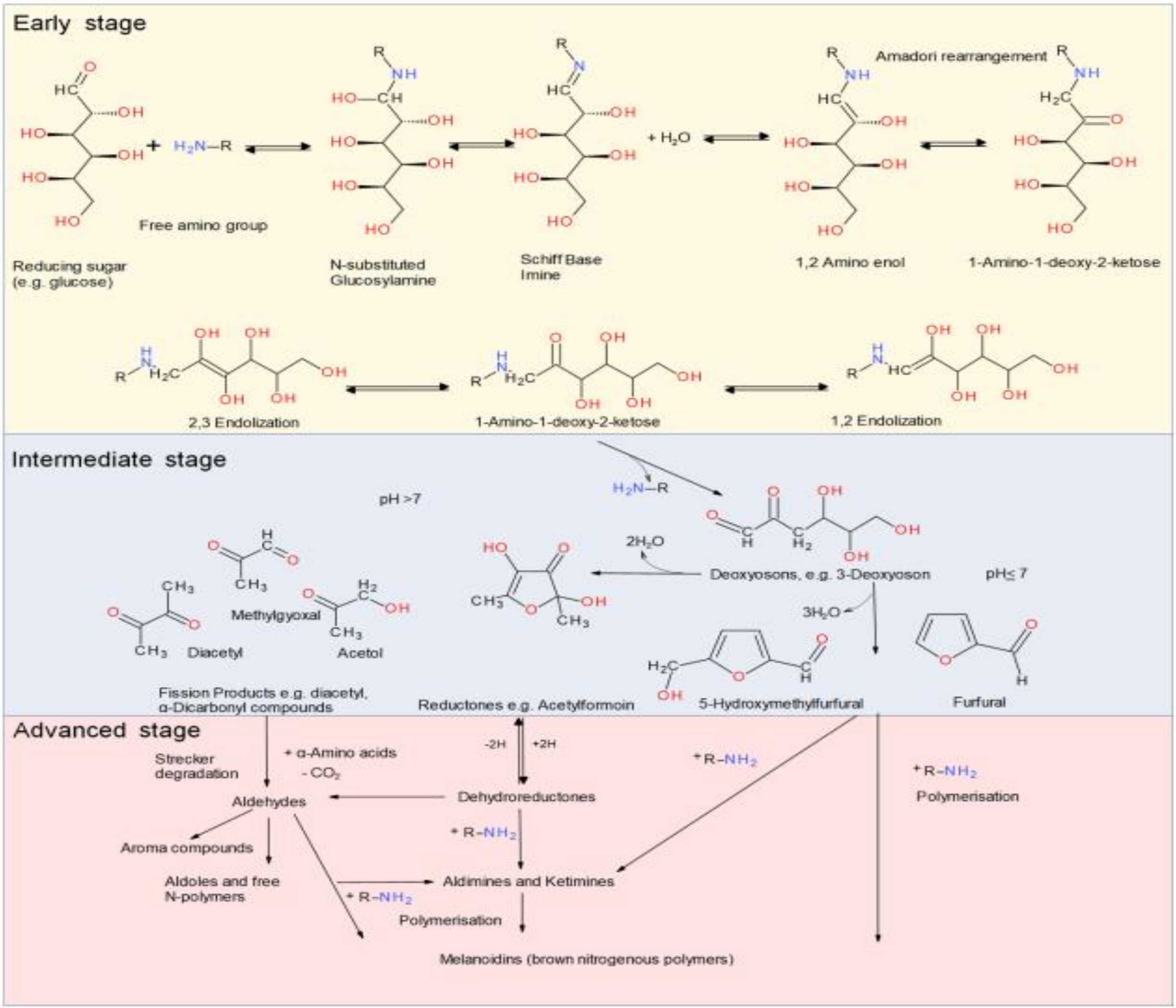

Figure 1. Maillard reaction [4,5]

The Amadori/Heyns products degrade to reductones and a variety of fission products at alkaline pH via 2,3-enolization, including acetol, pyruvaldehyde, and diacetyl. All of these fission products are very reactive substances that react violently [5]. These mechanisms produce a large number of highly reactive compounds that participate in the Maillard reactions advanced or final stage reactions [5].These processes result in a large amount of highly reactive compounds that take part in the further reactions of the advanced or final stage of the Maillard reaction [5]. The final stage of the Maillard reaction depends on reaction conditions such as environment, and involves the dehydration and disintegration of the early reaction products via pathways such as Strecker degradation [8].Cyclizations, dehydrations, retroaldolizations, enolizations, oxidations, fragmentations, rearrangements, isomerizations, and additional condensations are just a few of the reactions that result in the synthesis of a huge number of compounds that are still poorly characterised [8, 9, 5,6]. Although some colour is produced in the intermediate stage, the majority of colour is produced in the final step, when melanoidins are synthesised [9,5, 10]. Brown pigment is caused by melanoidins, which are nitrogen-containing polymers and co-polymers. They have been found to have an impact on sensory qualities [5, 11, 12].

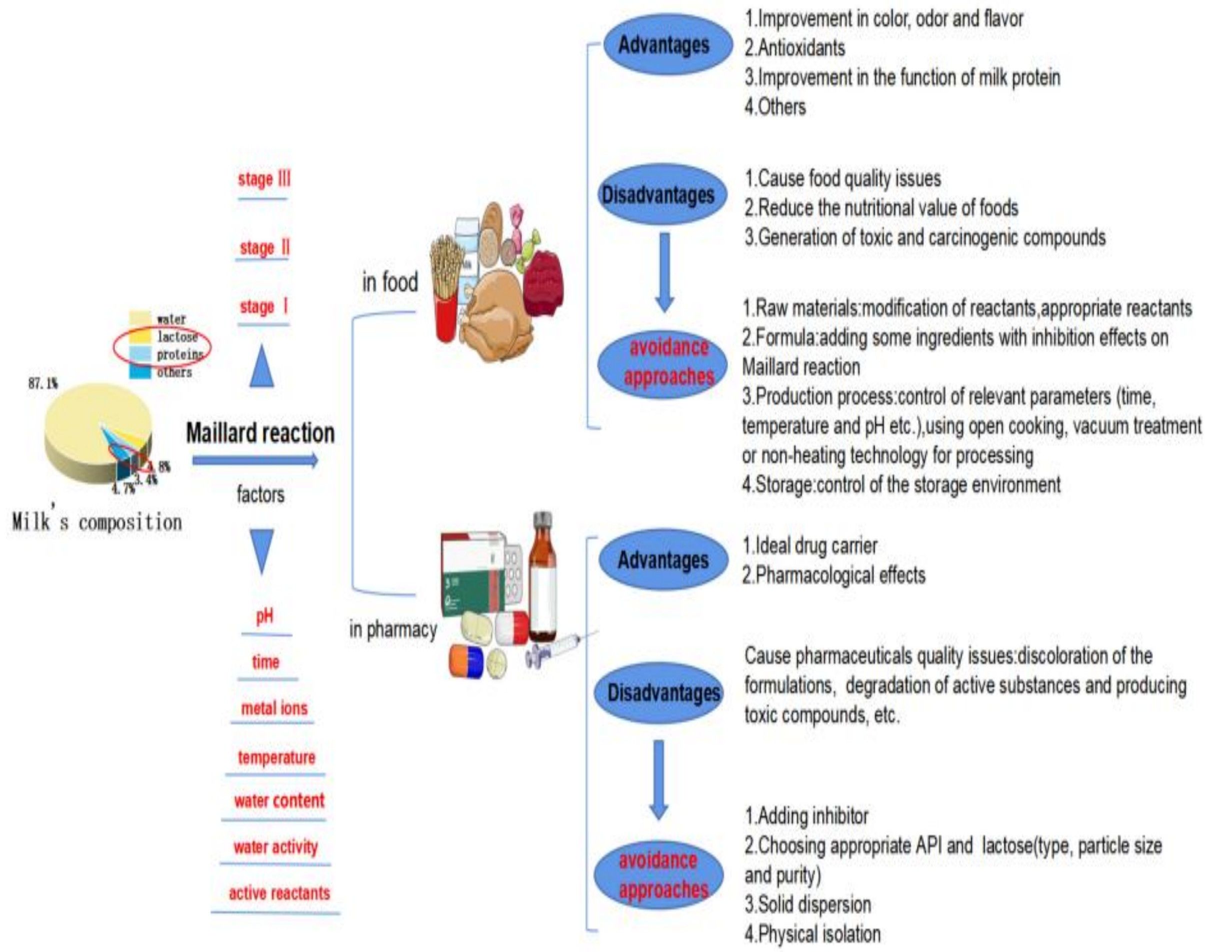

Figure2: Maillard reaction based on milk ingredients in food and pharmaceutical product [13]

III.CONCLUSION

Maillard reaction is desirable in food such as Coffee, bread crust, toast, french fried potatoes more appetizing colours, aromas, and flavours. Furthermore, antioxidant-rich Maillard reaction products offer higher benefits than synthetic antioxidants employed as natural antioxidants in food. Milk protein has been widely used in food due to its unique properties, but its application has been limited due to its high sensitivity to its surroundings. The Maillard reaction has the potential to increase the functioning of milk protein and its use in food. The Maillard process, on the other hand, has a negative impact on food, altering its colour and odour, reducing its nutritional value, and producing toxic substances that are harmful to human health. Milk protein could be used as a drug carrier in pharmaceutical formulations because of the Maillard reaction.The Maillard reaction has both good and detrimental effects depending on the circumstances and diet. Inhibitors of the Maillard reaction have also been discovered to control the Maillard reaction's drawbacks in specific foods. Several sulfhydryl substances, particularly L-cys, have been reported to effectively reduce browning and HMF level.

ACKNOWLEDGEMENTS

My parents, Dr. Kamar Jahan and Late Md. Quasim, are grateful to the authors.

REFERENCES

[1]Kawamura, S. I., 1983 Seventy years of the Maillard reaction. In The Maillard Reaction in Foods and Nutrition; ACS Symposium Series; ACS: Washington, DC, USA, Chapter 1:3–18.

[2]Rifai, L. and Saleh, F.A., 2020. A review on acrylamide in food: occurrence, toxicity, and mitigation strategies. *International journal of toxicology*, *39*(2):93-102.

[3]Kumar, V. and Banker, G.S., 2005. Maillard reaction and drug stability.In *Maillard Reactions in Chemistry, Food and Health*.Woodhead Publishing,20-27.

[4]Hodge, J.E., 1953. Dehydrated foods, chemistry of browning reactions in model systems. *Journal of agricultural and food chemistry*, *1*(15):928-943.

[5]Martins, S.I., Jongen, W.M. and Van Boekel, M.A., 2000. A review of Maillard reaction in food and implications to kinetic modelling. *Trends in food science & technology*, *11*(9-10):364-373.

[6] Ames, J.M., 1992. The maillard reaction.In *Biochemistry of food proteins*.Springer, Boston, MA.,99-153.

[7]Wrodnigg, T.M. and Eder, B., 2001. The Amadori and Heyns rearrangements: landmarks in the history of carbohydrate chemistry or unrecognized synthetic opportunities?. *Glycoscience*,115-152.

[8]De Oliveira, F.C., Coimbra, J.S.D.R., de Oliveira, E.B., Zuñiga, A.D.G. and Rojas, E.E.G., 2016. Food protein-polysaccharide conjugates obtained via the Maillard reaction: A review. *Critical Reviews in Food Science and Nutrition*, *56*(7):1108-1125.

[9]Friedman, M., 1996. Food browning and its prevention: an overview. *Journal of Agricultural and Food chemistry*, *44*(3):631-653.

[10] Zhang, Y. and Zhang, Y., 2007. Formation and reduction of acrylamide in Maillard reaction: a review based on the current state of knowledge. *Critical reviews in food science and nutrition*, *47*(5):521-542.

[11] Wang, H.Y., Qian, H. and Yao, W.R., 2011. Melanoidins produced by the Maillard reaction: Structure and biological activity. *Food chemistry*, *128*(3):573-584.

[12] Starowicz, M. and Zielinski, H., 2019. How Maillard reaction influences sensorial properties (color, flavor and texture) of food products? *Food Reviews International*, *35*(8):707-725.

[13] Xiang, J., Liu, F., Wang, B., Chen, L., Liu, W. and Tan, S., 2021. A literature review on maillard reaction based on milk proteins and carbohydrates in food and pharmaceutical products: advantages, disadvantages, and avoidance strategies. *Foods*, *10*(9):1998.