Article ID 42402101

Significance and Importance of Enzymatic Modifications of Milk Proteins

Prince[1]*, Somveer[2], Dimple[3] and Nitish[4]

[1]Ph. D. Scholar, Dairy Chemistry Division, ICAR-National Dairy Research Institute, Karnal

[2]Ph. D. Scholar, Dairy engineering Division, ICAR-National Dairy Research Institute, Karnal

[3]M. Tech. Scholar, Department of Dairy Chemistry, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar

[4]B.Tech. (Dairy Technology), College of Dairy Science and Technology, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar.

*Corresponding Author: princedhanda29111998@gmail.com

The demand of milk and dairy products increasing day by day because milk and dairy products supplies nutrients which are essential for humans. Protein is an essential macronutrient which is required for the maintenance of the human body. Milk contains about 3.5% of protein by mass. Milk proteins comprises of about 80% casein and 20% whey protein. There are four forms of casein protein which are found in milk protein, which includes αS1-CN, αS2-CN, β-CN, and κ-CN. Traditionally, the quality of milk proteins is improved by altering their composition. There are some group of people which are allergic to the milk proteins and due to which they are not able to consume milk or milk proteins so to avoid that and increase the nutritional value of milk proteins the milk proteins are modified by three ways i.e. physically, chemically and enzymatically.

Significance and Importance of Modification of Milk Proteins

The modification of milk proteins to done enhance or alter the functional properties of proteins which may increase their applications in food. Modifications of proteins can be done by physical, chemical and enzymatic methods. Enzymatic modification of proteins includes- partial or complete hydrolysis, incorporation of crosslinks within or between the protein, and attachment of functional groups or side chains to the protein. Milk proteins have a very low or limited application in the food industry so to increase the application of milk proteins in the food industry, the physico-chemical properties of the milk proteins need to be modified in such way that the functionality or properties match the intended use of the proteins. This can be done with the help of modifications of milk proteins. Modifications of milk proteins may vary or enhance one or more of the functional properties, which allows development of proteins with a wide range of functional properties. The milk proteins modified with the help of such methods may prove to be useful in the growing area of functional foods. The functionality of milk proteins is governed by physico-chemical properties of these protein, their interactions with other proteins and non-protein components of the food system, and also with the environmental conditions of the food formulations. The physicochemical properties of milk proteins include- their molecular weight, composition and sequence of amino acids, their conformation, net charge on the surface, and the effective hydrophobicity of the proteins. The aim of modifying milk proteins is not only to incorporate desired functionality into the protein, but also to improve their nutritional value, prevent the deteriorative reactions (e.g., Maillard reaction), or change in physical attributes (e.g., texturization) of the protein. Proteolytic hydrolysis of proteins is done by enzymatic method which generally results in a mixture of peptides. The functional property of proteins is usually altered in a way which depends on the extent of hydrolysis of proteins by the enzymes. Enzymes are also capable of introducing intramolecular and/or intermolecular crosslinks into the protein. Various types of enzymatic modifications of milk proteins and their significance and importance are discussed below.

Enzymatic Modification

There are a large number of advantages of using enzymes to incorporate modifications in the structure of the proteins which results in altering its function. Generally, enzymes are very specific for the type of reactions catalyzed by them. Therefore, there is almost negligible or very little chance that the undesirable side reactions may occur, which, in combination with the mild conditions necessary for

catalysis by enzyme, results in very low tendency to form by-products which may be toxic. Enzymes are very effective even at low concentrations. The most widely used enzymes for modifications of milk proteins are proteases. Selected peptide bonds are hydrolyzed by them which results in decrease in molecular weight of the proteins, changes in conformation, and the hydrophilicity is also increased due to exposure of newer carboxyl and amino groups. Net hydrophobicity of some whey proteins can be increased by exposure of a polar amino acid residues by limited hydrolysis which results in unfolding of the polypeptide chain.

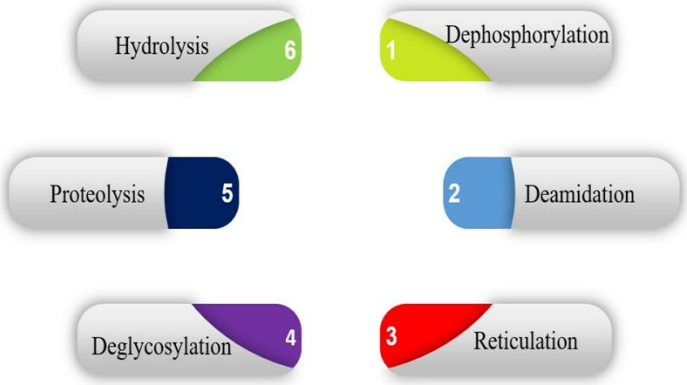

Fig. 1: Various types of enzymatic modifications of milk proteins

Generally, on proteolysis due to change in the size, structure, and polarity, there are huge changes in the of protein functional behavior of the protein. Some specific properties of the hydrolysates are also dependent on the degree of hydrolysis, which is affected by the activity of the proteases, physical and chemical characters of the milk proteins, and the conditions under which the reaction is occurring. There would be an increase in solubility and decrease in viscosity as the hydrolysis progresses. In addition to these, the proteolysis of milk proteins leads to reduced tendency to form gel, increase in volume of foam upon whipping, decreased in the stability of the foam, and increase in the thermal stability. The emulsifying power may also be altered; however, this effect varies with the nature of the substrate i.e. protein. Various types of enzymatic modifications are shown in figure 1 and their effect on the milk proteins are shown in table 1.

Table 1- Various types of enzymatic modifications and their effect on the milk proteins

S. No	Enzymatic Modifications	Various Effects of Enzymatic Modifications on Milk Proteins
1	Dephosphorylation	The pI of caseins is shifted towards the neutral pH which resulted in increased solubility of caseins at acidic pH.
2	Deamidation	The caseins became more electronegative because of formation of additional carboxyl groups, which leads to a decrease in isoelectric pH towards the lower pH values.
3	Reticulation	This type of enzymatic modification cross-links proteins. The cross-linked proteins form nanogel particles which are more stable to heat-induced coagulation as compared to normal casein micelles.
4	Deglycosylation	After this type of enzymatic modification, the proteins have shorter acid gelation time and final firmness of the proteins is higher. This is due to the increase in number of hydrophobic sites on the surface.
5	Proteolysis	Caseins become more soluble at their isoelectric pH upon hydrolysis. This type of enzymatic of caseins may improve or may also reduce the emulsifying and/or foaming properties of the protein, which depends on the extent of proteolysis.

Conclusions

It is very important to understand about the various types of modifications of milk proteins by enzymes to increase the utilization of milk proteins in food formulations. There are also several advantages of enzymatic modifications over other type of modifications. Some proteins lack in some properties but only with the help of small enzymatic

modifications the properties are greatly enhanced. Some modifications like proteolysis shows adverse effects when these are not controlled. However, the controlled or intentional proteolysis is very important for manufacturing of fermented dairy products.

Future Aspects

There are a large number of limitations in using the milk proteins in various foods these can be overcome with the help of such modifications. These modifications of milk proteins with the help of enzymes can also be used for new product development. The modification of milk proteins has the potential to increase the digestibility of milk proteins or to reduce their allergenicity which should be exploited so that the allergenic persons can also consume milk proteins.

References

Broyard, C. and Gaucheron F. (2015). Modifications of structures and functions of caseins: a scientific and technological challenge. *Dairy Science & Technology*, **95** (6), pp.831-862.

Kester, J. and Richardson, T. (1984). Modification of Whey Proteins to Improve Functionality. *Journal of Dairy Science*. **67**:2757-2774.

* * * * * * * *