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A Review on Amino Acids Based Surfactants

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ABSTRACT

Amino acids, essential building blocks of proteins and life, possess both hydrophilic and hydrophobic properties that make them versatile components in the synthesis of surfactants. The 20 standard amino acids, along with others not typically involved in protein biosynthesis, provide a wide range of functionalities for designing anionic, cationic, and zwitterionic amphiphiles. Their interactions with surfactants, mediated by hydrophobic forces, hydrogen bonding, and electrostatic attractions, are critical to many chemical and biological processes. These interactions allow amino acids to encapsulate within surfactant micelles or associate with their surfaces, impacting protein folding, stabilization, and overall biochemical functionality. Understanding these molecular dynamics is crucial for advancing the application of amino acids and surfactants in various industrial and biological systems.

INTRODUCTION

The 20 standard amino acids, along with a few additional ones not involved in protein biosynthesis, provide a versatile toolkit for synthesizing surfactants. These amino acids can be used to create anionic, cationic, and zwitterionic amphiphiles, and by selecting the appropriate amino acid as a starting material, surfactants with multiple functional groups can be developed. Amino acids are essential molecules that combine to form proteins, serving as the fundamental components of life [1-8]. When proteins are broken down during digestion, amino acids are produced, which the body then utilizes to construct proteins necessary for various bodily functions.

Table showing list of 20 amino acids

Sl. No.	Name	Formula
1.	Glycine	$C_2H_5NO_2$
2.	Alanine	$C_3H_7NO_2$
3.	Valine	$C_5H_{11}NO_2$
4.	Leucine	$C_6H_{13}NO_2$
5.	Isoleucine	$C_6H_{13}NO_2$
6.	Methionine	$C_5H_{11}NO_2S$
7.	Proline	$C_5H_9NO_2$
8.	Tryptophan	$C_{11}H_{12}N_2O_2$
9.	Phenylalanine	$C_9H_{11}NO_2$
10.	Serine	$C_3H_7NO_3$
11.	Cysteine	$C_3H_7NO_2S$
12.	Asparagine	$C_4H_8N_2O_3$
13.	Glutamine	$C_5H_{10}N_2O_3$
14.	Threonine	$C_4H_9NO_3$
15.	Tyrosine	$C_9H_{11}NO_3$
16.	Aspatic Acid	$C_4H_7NO_4$
17.	Glutamic Acid	$C_5H_9NO_4$
18.	Histidine	$C_6H_9N_3O_2$
19.	Lysine	$C_6H_{14}N_2O_2$
20.	Arginine	$C_6H_{14}N_4O_2$

Surfactants are compounds that form self-organized molecular assemblies known as micelles in solutions, whether in water or oil, and they tend to accumulate at the boundary between a solution and another phase, such as gas or solid. For a surfactant to exhibit these characteristics, its chemical structure must include two distinct functional groups with varying affinities within the same molecule. Typically, surfactant molecules consist of an alkyl chain containing 8 to 22 carbon atoms. This chain is referred to as the hydrophobic group, which does not have an affinity for water (in aqueous systems, it's called hydrophobic; in lipid systems, it is known as lipophilic). In addition, surfactants feature a hydrophilic group that interacts well with water. This combination of contrasting properties is referred to as an amphiphilic structure [9-16].

INTERACTION OF AMINO ACID WITH SURFACTANTS

Interactions between amino acids and surfactants are essential to many chemical and biological processes. Proteins are made up of amino acids, which have both hydrophilic and hydrophobic groups. The primary factor influencing the interactions between amino acids and surfactants is their amphiphilic nature, which is characterized by the presence of both hydrophobic (repellent) and hydrophilic (attracting) areas. In a solution, amino acids and surfactants often interact through hydrophobic, hydrogen bonding, and electrostatic forces. For example, polar or charged amino acid side chains are drawn to the hydrophilic heads of surfactants, whereas hydrophobic amino acid side chains may associate with the hydrophobic tails of surfactants. Amino acids may encapsulate themselves in micelles or interact with their surface as a result of

this interaction. In conclusion, the interactions between amino acids and surfactants are driven by their amphiphilic nature and play a key role in various chemical and biological processes. These interactions, governed by hydrophobic forces, hydrogen bonding, and electrostatic attractions, allow amino acids to associate with surfactant micelles either at the surface or within the structure [17-20]. The way in which amino acid side chains—whether hydrophilic or hydrophobic—interact with different parts of the surfactant molecule highlights the complexity of these interactions, which are fundamental to processes like protein folding, stabilization, and biochemical functionality in diverse systems.

CONCLUSION

The building blocks of proteins, amino acids can be used to create a wide range of surfactants, including cationic, zwitterionic, and anionic forms. Surfactants with several functional groups can be made for a variety of uses by choosing the right amino acids. Surfactants are important for emulsification, detergency, and stability because of their amphiphilic structure, which combines hydrophobic alkyl chains with hydrophilic groups to create micelles that accumulate near interfaces. Numerous chemical and biological processes depend heavily on the interactions between amino acids and surfactants, which are fueled by hydrophobic, hydrogen bonding, and electrostatic forces. The surface or internal structure of surfactant micelles can be occupied by amino acids, which can impact protein folding and biochemical activity.

REFERENCES

Ahmed, N. N., Ansari, N. H., Ali, M. S., Tariq, M., & Khan, A. B. (2024). Interaction of DL-Valine/DL-Serine with Cationic and Anionic Surfactants in Aqueous Media: Volumetric, UV-visible Spectroscopic, and Conductometric Studies. *Colloid Journal*, *86*(4), 588–609. https://doi.org/10.1134/s1061933x2460009x

Ali, A., & Ansari, N. H. (2010). Studies on the Effect of Amino Acids/Peptide on Micellization of SDS at Different Temperatures. *Journal of Surfactants and Detergents*, *13*(4), 441–449. https://doi.org/10.1007/s11743-010-1221-8

Ali, A., Ansari, N. H., Farooq, U., Tasneem, S., & Nabi, F. (2018). Study of Intermolecular Interactions of CTAB with Amino Acids at Different Temperatures: A Multi Technique Approach. *Zeitschrift Für Physikalische Chemie*, *233*(2), 167–182. https://doi.org/10.1515/zpch-2017-1070

Ali, A., Ansari, N. H., Farooq, U., Tasneem, S., Shahjahan, N., & Nabi, F. (2018). Interaction of Glycylglycine with Cationic Surfactants—Cetylpyridinium Chloride and Cetylpyridinium Bromide: A Volumetric, Ultrasonic and Conductometric Study. *International Journal of Thermophysics*, *39*(9). https://doi.org/10.1007/s10765-018-2426-8

Ali, A., Itoo, F. A. Ansari, N. H. (2011). Interaction of Some Amino Acids with Sodium Dodecyl Sulphate in Aqueous Solution at Different Temperatures. *Zeitschrift Für Naturforschung A*, *66a*, 339. https://doi.org/10.5560/zna.2011.66a0339.

Ali, A., Patel R., Shahjahan, Bhusan, V., Ansari, N. H. (2012). Viscometric and Refractometric Studies of Glycine, Alanine, Valine and Glycylglycine in Aqueous Sucrose at Different Temperatures. *Journal of Indian Chemical Society, 89, 1335-1342.*

Ali, A., Patel, R., Shahjahan, N., & Ansari, N. H. (2010). Physicochemical Behavior of Some Amino Acids/Glycylglycine in Aqueous D-Galactose Solutions at Different Temperatures. *International Journal of Thermophysics*, *31*(3), 572–584. https://doi.org/10.1007/s10765-010-0742-8

Ali, A., Shahjahan, Ansari, N. H. (2010). Density and viscosity of α-amino acids in aqueous solutions of cetyltrimethylammonium bromide, *Russian Chemical Bulletin, International Edition,* 59(10), 1999 – 2004.

Ansari, N. H. (2023). Role of Surfactant in Dispersion of Carbon Nano Tubes to Use as Reinforcing Material for Biodegradable Nano Composites. *Physical Science & Biophysics Journal*, *7*(2), 1–3. https://doi.org/10.23880/psbj-16000254

Ansari, N. H. (2024) Significance of amino acids as plant bio-stimulant. *Agro Science Today,* 5 (6), 0902 – 0908.

Ansari, N. H., Khan, A. A., Iqubal, S. M. S., Mohammed, T., & Asghar, B. H. (2024). Review on conductometric, volumetric and computational studies on surfactants-amino acids interactions. *Journal of Umm Al-Qura University for Applied Sciences*, *10*(3), 593–602. https://doi.org/10.1007/s43994-024-00125-1

Bordes, R., & Holmberg, K. (2015). Amino acid-based surfactants – do they deserve more attention? *Advances in Colloid and Interface Science*, *222*, 79–91. https://doi.org/10.1016/j.cis.2014.10.013

Holeček, M. (2018). Branched-chain amino acids in health and disease: metabolism, alterations in blood plasma, and as supplements. *Nutrition & Metabolism*, *15*(1). https://doi.org/10.1186/s12986-018-0271-1

Javed, M., Iqbal, S., Fatima, I., Nadeem, S., Mohyuddin, A., Arif, M., Amjad, A., Shahid, S., Alshammari, F. H., Alahmdi, M. I., Elkaeed, E. B., Alzhrani, R. M., Awwad, N. S., Ibrahium, H. A., & Qayyum, M. A. (2022). Interactions between amino acids and a cationic surfactant in binary solvent system. *Colloids and Interface Science Communications*, *48*, 100623. https://doi.org/10.1016/j.colcom.2022.100623

Shahid, S., Sharma, B. B., Khan, A. A., & Ansari, N. H. (2023). Management of plant diseases by surfactants, 121-127.

Shingda, S. R., Ali, P. S., Gandhare, N. V., Pathan, N. B., & Ansari, N. H. (2021). Investigation of mechanistic interactions between Rifampicin and bovine serum albumin in the presence of different surfactants. *Journal of Dispersion Science and Technology*, *44*(6), 1075–1084. https://doi.org/10.1080/01932691.2021.1997759

Singh, S. K., & Kishore, N. (2004). Volumetric properties of amino acids and hen-egg white lysozyme in aqueous Triton X-100 at 298.15 K. *Journal of solution chemistry*, *33*, 1411-1427.

Singh, S. K., Kundu, A., & Kishore, N. (2004). Interactions of some amino acids and glycine peptides with aqueous sodium dodecyl sulfate and cetyltrimethylammonium bromide at T= 298.15 K: a volumetric approach. *The Journal of Chemical Thermodynamics*, *36*(1), 7-16.

Wu, G. (2009). Amino acids: metabolism, functions, and nutrition. *Amino Acids*, *37*(1), 1–17. https://doi.org/10.1007/s00726-009-0269-0

Zhao, X., Wang, Z., Liu, Y., Yuan, B., Song, L., Penfold, J., Li, P., & Yan, Z. (2024). Synthesis and interface behaviors of amino acid surfactants with naturally derived branched hydrophobic chains. *Journal of Molecular Liquids*, *398*, 124328. https://doi.org/10.1016/j.molliq.2024.124328