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Modeling Calcium-induced Solubility in Caprine Milk Caseins Using a Thermodynamic Linkage Approach

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The phenomena of calcium-induced precipitation of bovine and caprine whole caseins (salting out) and the resolubilization of these proteins at higher calcium concentrations (salting in) are thermodynamically linked with changes in protein solubility resulting from calcium binding. The differences in calcium sensitivities of caprine whole caseins under various conditions of temperature and ionic strength (KCl) appear to be correlated with the content of the α_{s1}-casein component. However, the solubility behavior of caprine whole caseins characterized by low content of α_{s1}-casein (5% of total) is more closely related to solubility properties displayed by bovine casein (38% of total). The properties of whole caprine casein high in or, α_{s1}-casein content (17% of total) appear to be dominated by the binding of calcium to higher affinity sites (phosphate groups), which results in less stability. Decreasing the temperature to 1°C dramatically altered the salting out of both caprine caseins but not bovine casein. These results suggested that the solubility and calcium-binding properties of caprine whole caseins are in part determined by hydrophobic interactions. However, salting out of both of the caprine caseins is effected by competitive K^+-Ca^{2+} binding at 1°C, indicating a role for ionic interactions as well. Because such KCl-dependent changes do not occur in whole bovine caseins, protein-protein interactions appear to be stronger in this case. These results show that alteration in casein composition can clearly effect the functionality of the whole casein and that thermodynamic linkage analysis can readily quantitate these differences that are linked to calcium binding.

Key Words: calcium binding • caprine casein • α_{s1}-casein • thermodynamic linkage

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