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The production of dairy powders has significantly increased in the last decade and, currently, it represents a fundamental portion of the dairy industry market. Controlling and improving powder nutritional properties has become more and more important due to the increasing number of end-users all over the world. Nevertheless, a full understanding of the physics governing the droplet-to-particle transition in typical industrial dryers is still far from being achieved. To this purpose, the single droplet approach has been used to explore the drying dynamics at the lab scale in dairy simplified model systems, such as mixes of the two main milk proteins: the whey proteins (WPI), globular rigid colloids, and the casein micelles (NPC), characterized by a typical deformable sponge-like structure. We focused on the evaporation of droplets of WPI/NPC suspensions with different overall protein concentration (ϕ_p) and composition ($WPI\%_R$). We investigated the skin formation at the air-liquid interface and we explored the paradigm linking protein physico-chemical properties to skin rheology and, consequently, to final droplet morphology. A general overview of the process was carried out observing droplet shape evolution by profile visualization and evaluating the drying kinetics by mass measurements. Moreover, a characterization of interfacial organization at the colloidal scale was provided by interfacial rheology, using the oscillatory drop method, and scanning electron microscopy. Our outcomes revealed, under certain conditions, WPI selective segregation on the external part of droplet surface, which significantly affected dry particle shape. Our results represent a potential useful tool for industrial applications to control powder characteristics and they contribute to the better understanding of the evaporation mechanisms in polydisperse colloidal systems.