Bonding Strength, Microstructure, and Shelf Life Stability of Whey Protein-based Glue Sticks

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Whey is the byproduct of cheese making. Considering its unique functionality, and environmental pollution caused by whey disposal, it is necessary to explore whey protein applications in non-food areas. Glue sticks are widely used in schools and offices, which may be made with synthetic polymers such as polyvinylpyrrolidone (PVP). PVP is slightly hazardous to human in case of direct contact, ingestion, and inhalation. The major whey proteins are small globular proteins that can be modified and polymerized by chemical or physical means to improve their functionality to be used as a binder in glue sticks.

In this study, a new safe glue stick prototype using whey protein isolate (WPI) and PVP was optimized. The PVP content in the prototype (8-12% w/w) was much lower than the average commercial levels (usually above 20%). The prototype was analyzed for bonding strength, hardness, shelf life stability, glue setting time, micro-structure, and free formaldehyde emission in comparison with a commercial control. The bonding strength of the prototype of 0 month was 219.44±1.80 N, which was only slightly lower ($P<0.05$) than the control (228.04±3.10 N), but was comparable ($P>0.05$) to the control after 6 months of storage at 23℃ (Prototype: 205.09±16.47 N; Control: 200.93±11.63 N) and 40℃ (Prototype: 220.58±16.34 N; Control: 208±28.70 N). Hardness of the prototype gel (23.48±3.42 N) was comparable to the control (21.14±1.82 N). The prototype is easy to be applied on paper and easy to be extended and retracted in push-up tubes. The setting time of both prototype and control was around 20 min.

SEM micrographs showed that the prototype had a rougher cracked surface, which may indicate improved the initial crack propagation energy of this system. There was no emission of free formaldehyde from either prototype or control. Shelf life tests are underway to further determine the storage stability of this new product.

Key words: Scanning electron microscopy (SEM), glue setting time, and polyvinylpyrrolidone