Long-term release rate of a nutritional supplement from a biodegradable polymer matrix

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Introduction

For the purposes of ruminant nutrition, a 6-month timeframe is the ideal amount of time for the delivery of trace element and minerals. As a starting element, copper was chosen as it is the most commonly observed trace element deficiency worldwide. Though not every available form of copper is nutritionally equal with each form maintaining its own level of bioavailability. The highest values of bioavailability in the rumen is those forms of copper which are chemically bound to an amino acid, such as copper glycinate (CuGly) (Fig. 1).

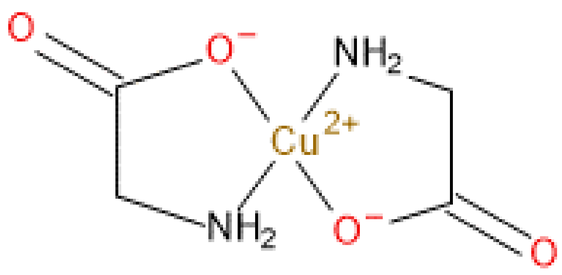

Fig.1 Chemical structure of copper glycinate

The natural layout of a ruminants digestive system lends itself well to the administration of a single large dosage of supplement with the aim of being released slowly over the entire grazing period wherein the animal is susceptible to developing a nutrient deficiency. The aim of such supplementation is for a device to reside in the reticulum (Fig.2) where it will slowly release its active agent over an ideal 6-month timeframe

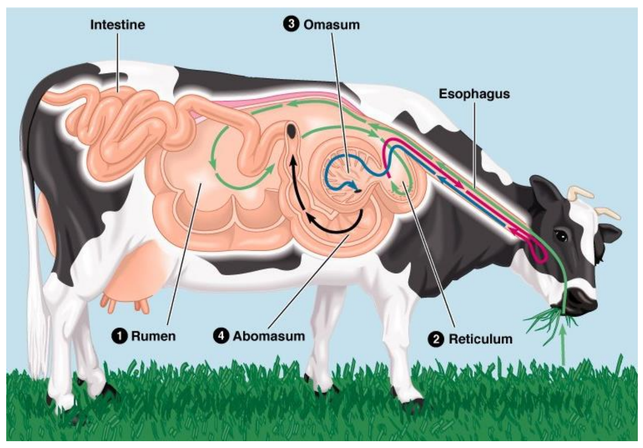

Fig.2 Ruminant digestive system (Addison Wesley Longman Inc, 2020)

Objective

The objective of this study was to observe whether alteration of polymeric ratios would allow for alteration and control of the release rate of CuGly for a long-term application. The determination of CuGly release rate was carried out using a Shimadzu UV-Vis spectrophotometer. Upon determination of the maximum absorbance (λ_{max}) of the CuGly solution, shown in Fig. 3 to be 625nm, measurements were taken of the release rate at weekly intervals over a 4-week period.

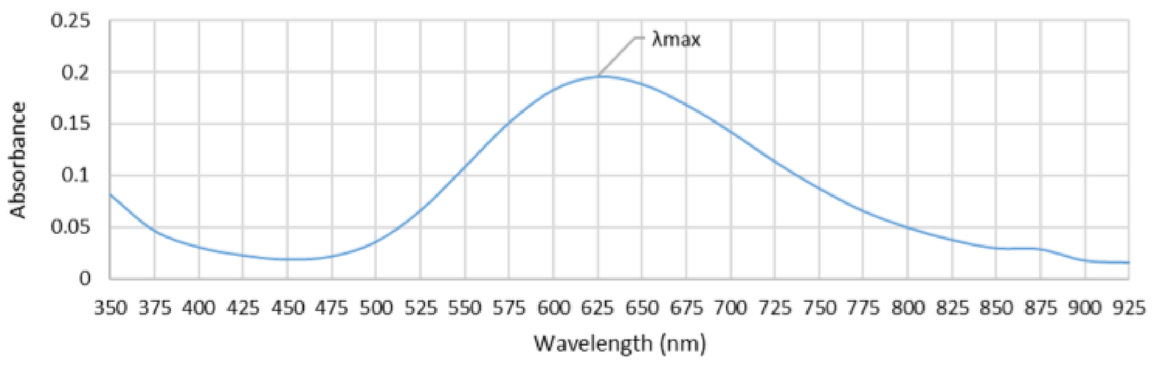

Fig.3 Wavelength scan determined the λmax of CuGly to be 625nm

Results

Fig. 4 offers a visual representation of the differing release profiles achievable through altering the polymeric ratio. Combined with Fig. 5 it is very apparent that Formulation C releases the supplement much more rapidly than Formulations A & B. This is due to Formulation C containing a significantly higher weight percentage of the hydrophilic component of the system. Also of note is the lack of correlation between the release of mineral from the matrix and the loss in mass of the system. This would indicate the release of mineral is controlled via a diffusion mechanism.

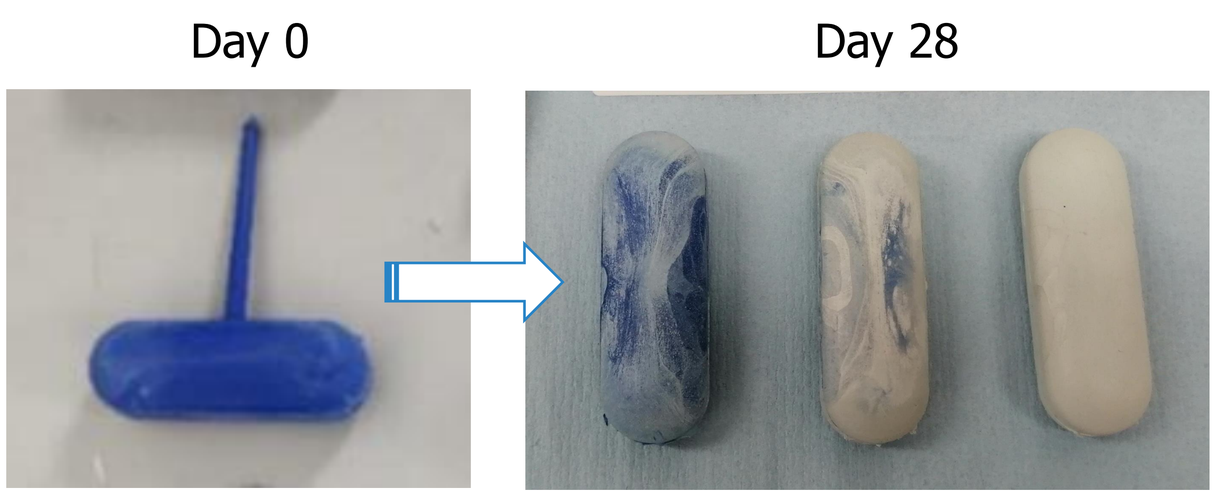

Fig.4 Visual representation of the differing release rates possible through polymer ratio alteration (0-28 days)

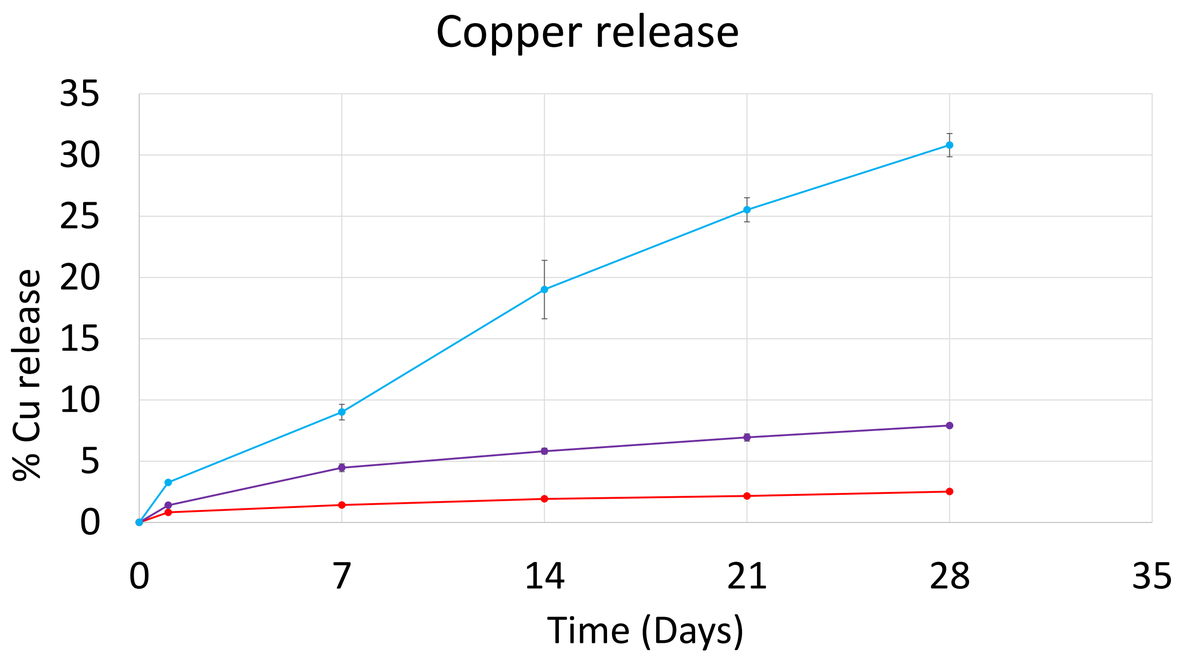

Fig.5 Release rate of CuGly samples over 28 days (red: formulation A, purple: formulation B, blue: formulation C)

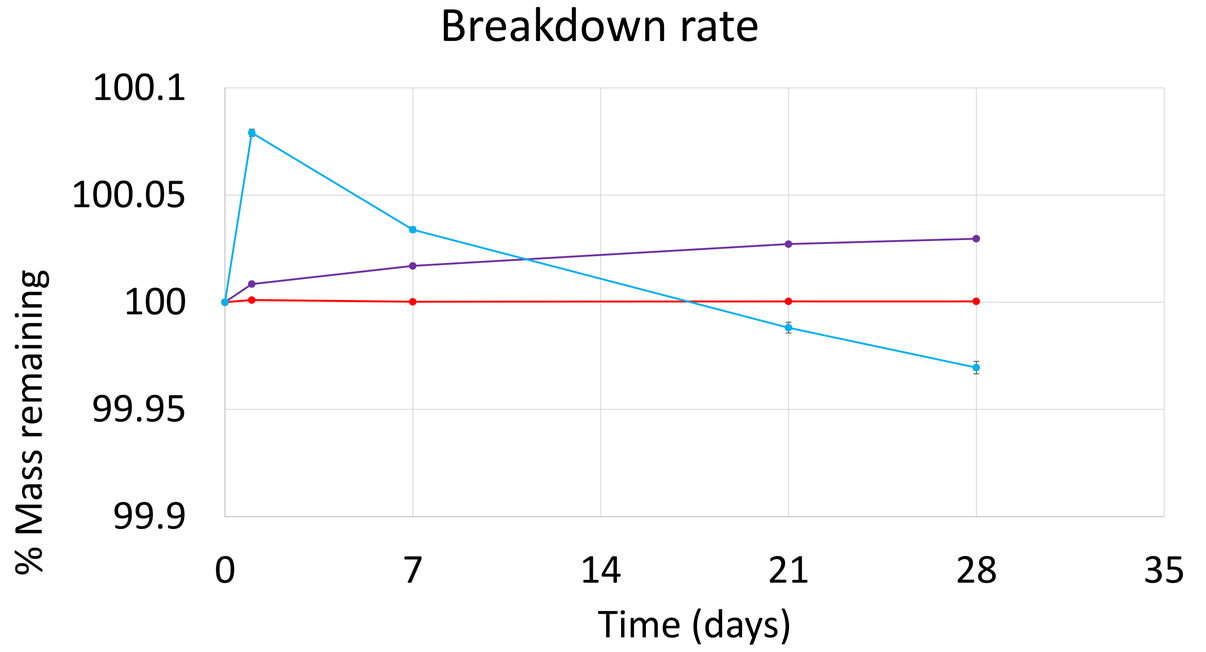

Fig.6 Breakdown rate of samples over 28 days (red: formulation A, purple: formulation B, blue: formulation C)

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