

Formulating Veterinary Soft Chews for Texture and Palatability

To improve and promote the palatability of soft chew dosage forms for companion animals.

For veterinary supplements administered by way of the mouth, animal health companies strive to develop highly palatable dosage forms that are voluntarily accepted by companion animals to improve acceptance and convenience^[1]. Dosing acceptance is a well-known issue within the field of oral veterinary formulations, often resulting in sub-par treatment outcomes^[2]. The ideal formulation should be consumed voluntarily by the animal^[3]. This is particularly true for treating chronic conditions, which may require frequent administration over extended periods of time. It is therefore in the interest of animal health companies to develop palatable products for both companion animals and pet parents.

Improved palatability can be achieved through formulation strategies that include taste-masking of active pharmaceutical ingredients (API), use of flavors and palatants, and incorporating excipients that are free of additives and preservatives.

Colorcon's Starch 1500®, Partially Pregelatinized Maize Starch and StarCap®, Superior Flow Maize Starch are proven and trusted naturally sourced starch-based excipients that have been successfully used to enhance palatability and dosing acceptance of veterinary formulations.

The Challenge

Osteoarthritis is a slowly progressive and debilitating disease that affects canines of all breeds. Pain and decreased mobility resulting from osteoarthritis often have a negative impact on the affected canine's quality of life, level of comfort, daily functioning, activity, behavior, and pet parent-pet relationship^[4].

Glucosamine, a naturally occurring compound, is a popular over-the-counter supplement commonly recommended by veterinarians for the support of healthy joints in canines that are unable to tolerate nonsteroidal anti-inflammatory drug (NSAID) therapy, or as an add-on therapy.

This case study investigated two formulation strategies using starch-based excipients in a soft chewable veterinary supplement containing glucosamine and combined chondroprotectors. In addition, manufacturing processes and resultant soft chew texture properties were evaluated.

Formulation Strategy for Oil Inclusion and Shelf-life Texture

In this study, a maize starch (Starch 1500® or StarCap®) was formulated into a chewable supplement to evaluate its performance as an absorption base and impact on texture properties.

Additionally, the ability of these excipients to absorb oil in a soft chew formulation can increase palatability, acceptance, and may allow higher active label claims and reduce the daily dosing regimen.

Table 1: Glucosamine Soft Chew Formulation

| Ingredients | Formulation 1 | Formulation 2 |
|-----------------------------|---------------|---------------|
| | % (w/w) | |
| Glucosamine HCl | 22.45 | 19.48 |
| Methylsulfonylmethane (MSM) | 14.03 | 10.50 |
| Starch 1500® (Colorcon) | 35.90 | - |
| StarCap® (Colorcon) | - | 35.90 |
| Previon | 0.60 | 0.60 |
| Vegetable Glycerin | 10.83 | 10.83 |
| Palasurance | 5.00 | 5.00 |
| Salmon Oil | 3.50 | 10.00 |
| Sunflower Lecithin | 4.00 | 4.00 |
| Water | 3.69 | 3.69 |
| Total | 100.00 | 100.00 |

Two soft chew formulas (Table 1) were evaluated for their rate and extent of oil absorption, curing and textural stability upon aging. The grade of starch-based (Starch 1500® or StarCap®) absorption base and inclusion level of salmon oil was varied to assess texture and palatability.

Batch Manufacturing Process

Cold feed extrusion was chosen as the preferred method for simple and efficient manufacturing. The soft chew dry ingredients were weighed and mixed using a planetary mixer. The liquid ingredients were weighed and mixed separately. The final soft chew weight was 2.5 grams to achieve the target active dose.

Soft Chew Manufacture (Blending, Extrusion, Curing, and Packaging)

A standard open-bowl planetary type mixer was used for blending. All dry ingredients were mixed for 5 minutes to ensure a homogenous blend. Liquid ingredients, except glycerin, were added and mixed for 3 minutes followed by the addition of glycerin and mixing for an additional 5 minutes. A mixing speed of 105 ± 5 rpm was maintained for all mixing steps.

After weighing and blending, each soft chew formula was extruded using a Diamond America TF-200 2-inch (4:1 L/D) extruder fitted with a knife assembly and medium bone shaped die (Figure 1). The mixed wet mass was transferred, extruded, cut to shape (300 min⁻¹), and collected on trays. The extruded soft chews were collected on racks, covered, and stored in a controlled environment for 24 hours prior to being packaged and labeled into resealable foil (5.0 MIL) gusseted pouches.

Figure 1: Diamond America TF-200



Image courtesy of Green Mountain Animal LLC (Burlington, VT)

Soft Chew Property Testing

Soft chew texture attributes were measured on Days 0, 1, 7, 14, 21 and 60 post-manufacture using a TA.XTPlus Texture Analyzer (Stable Micro Systems). This study presents two testing methods to quantify the firmness, toughness, adhesiveness, and resilience of soft chew dosage forms for companion animals. These metrics quantify the texture attributes of the soft chews and how those attributes change as a function of formulation, curing, and storage.

For both methods, each formulation was tested five times, and a fresh soft chew was used for each test. The blade was cleaned with alcohol and dried between each replicate and all testing was conducted in a controlled environment laboratory.

Soft Chew Resilience Test

In this method, soft chews were compressed using a TA-8 $\frac{1}{4}$ " ball probe to measure four attributes: firmness, toughness, resilience, and instant springback.

The test settings were Return to Start in Compression, 1.0 mm/sec Pre-Test Speed, 2.0 mm/sec Test Speed, 2.0 mm/sec Post-Test Speed, 2.0 mm Target Distance, with a 5.0 g Automatic Trigger.

Of the attributes, the firmness and toughness metrics were considered most applicable to the study outcomes when describing the texture of the soft chew formulations.

The firmness was calculated by measuring the average absolute peak force (g). Firmness is a property that describes a material's resistance to deformation. A firm material is one that is moderately resistant to deformation, while a hard material is one that displays substantial resistance to deformation.

The toughness of the soft chew was calculated by measuring the average positive area under the curve (AUC) on the downstroke (g.sec). Positive Area describes the toughness of the soft chew, where toughness is defined as a material's resistance to fracture [ability to absorb energy and plastically deform without fracturing].

Soft Chew Shear Test

In this method, soft chews were mounted in a TA-108s-GI Indexable Fixture for sample presentation, which was adjusted to accommodate the slight variances in soft chew thicknesses. A TA-46 Meullenet Owens Razer Shear (MORS) blade was used to shear completely through the soft chews to measure five attributes: initial stiffness, firmness, toughness, peak adhesive force, and work of adhesion.

The test settings were Return to Start in Compression, 1.0 mm/sec Pre-Test Speed, 2.0 mm/sec Test Speed, 5.0 mm/sec Post-Test Speed, 20.0 mm Target Distance, with a 5.0 g Trigger Force.

Of the attributes, the firmness, toughness, peak adhesive force, and work of adhesion metrics were considered most applicable to describing the mouthfeel of the soft chew formulations.

The firmness is represented by the absolute peak force (g). Toughness was measured by calculating the area under the curve on the downstroke of the blade (g.sec). Peak Adhesive Force was measured by recording the absolute minimum force (g). Work of Adhesion was calculated by measuring the area under the curve (negative area) during blade withdrawal (g.sec).

Toothpack is also a textural experience of interest when describing attributes of a soft chew and is experienced when soft chews bind to a pet's teeth. Toothpack can be described by the combination of adhesive force and work of adhesion.

Figure 2: Soft Chew Resilience Test

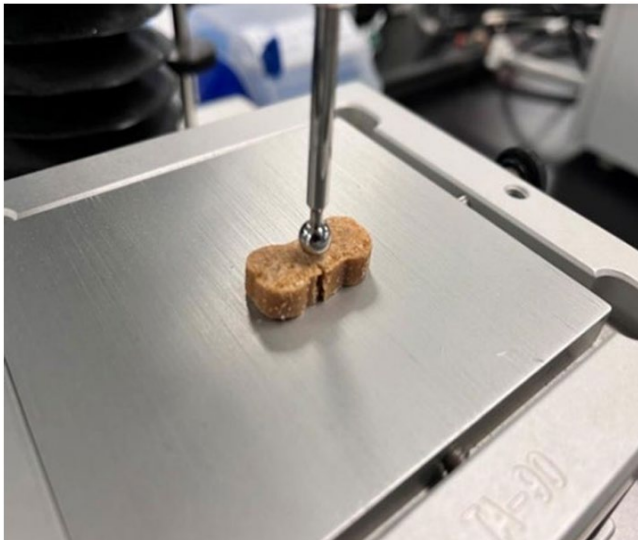
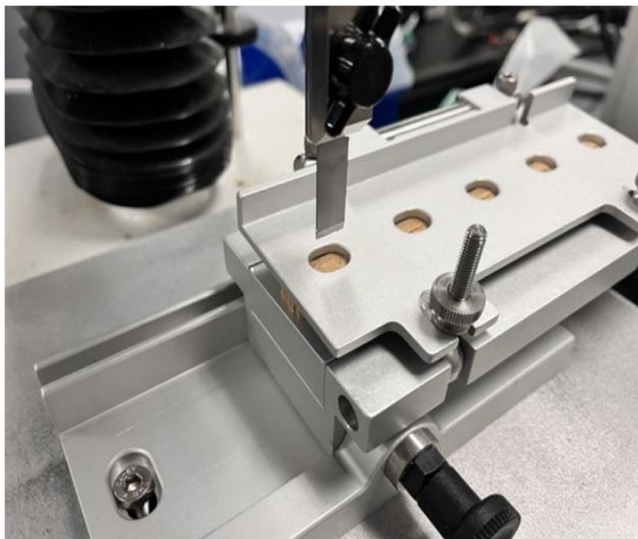


Figure 3: Soft Chew Shear Test



Results

Both formulations extruded well under standard conditions and produced soft chews with good initial and long-term textural properties.

Formulation 1, containing Starch 1500® as an absorption base, consistently tested as possessing a firmer and tougher texture. These samples also demonstrated a greater standard deviation between samples tested at each timepoint, suggesting a degree of variability in sample-to-sample textural properties.

Formulation 2, containing StarCap® as an absorption base, easily accepted the higher oil content and produced a softer initial chew and maintained that texture over the time measured. The formulation remained soft and moderately resistant to deformation without fracturing when compressed in either the Resilience or Shear tests.

Curing of soft chews can be described as the time between manufacture and packaging where the finished product may still be exhibiting changes in textural properties. During this time, the soft chews are typically placed on drying racks, under controlled environmental conditions, until oils are sufficiently absorbed to allow for packaging. Formulation 1 demonstrated a statistically significant curing, as shown by a change in texture properties from the initial and subsequent time points. Curing was complete by Day 3 as noted by the standard deviation of subsequent time points.

Interestingly, Formulation 2 demonstrated very little change in texture properties over the course of the study. These results suggest a rapid rate of oil absorption by the formulation when using the StarCap® excipient as an absorption base. Formulation 2 also demonstrated a low degree of toothpack as shown by the work of adhesion values in the MORS Shear test.

Figure 4: Firmness of Soft Chew (Average Absolute Peak Force)

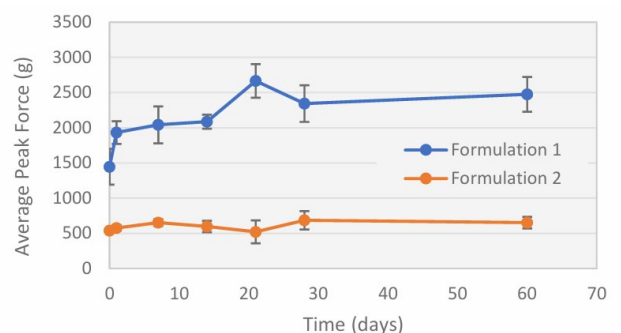


Figure 5: Toughness of Soft Chew (Average Positive AUC)

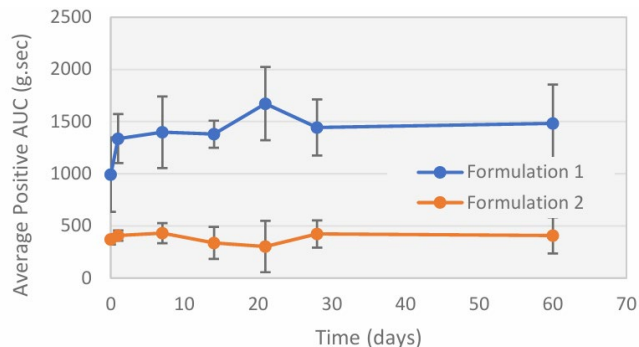


Figure 6: MORS Firmness of Soft Chew (Average Absolute Peak Force)

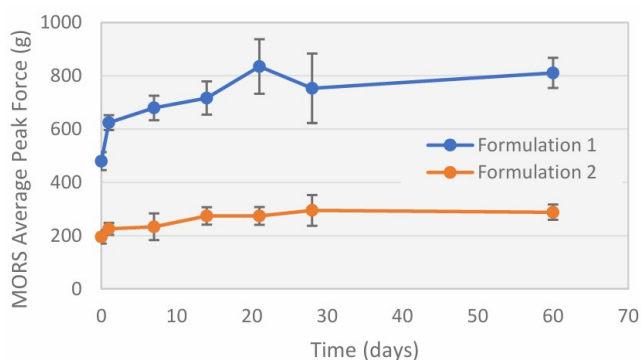


Figure 7: MORS Toughness of Soft Chew (Average Positive AUC)

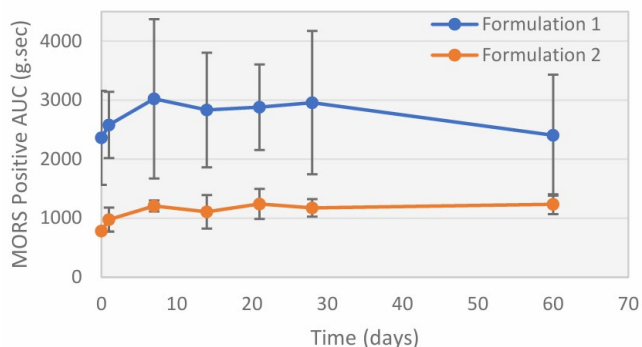
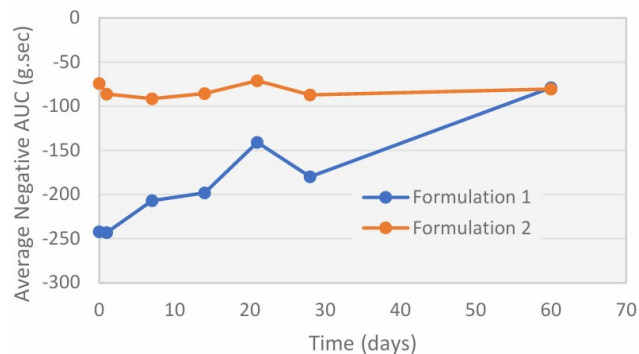


Figure 8: Work of Adhesion (Toothpick – Average Negative AUC)



Benefits of a Formulation Strategy Including Starch 1500® or StarCap®

Incorporating a starch-based excipient such as Starch 1500® or StarCap® in soft chew formulations resulted in a dosage form with good texture properties, low toothpick, and ease of manufacturability. This formulation strategy provides improved palatability and acceptance of a drug product or supplement for companion animals leading to better compliance and therapy outcomes.

The Solution

As a naturally sourced excipient from identity-preserved non-GM corn, manufactured in dedicated GMP facilities, the use of Colorcon's starch-based excipients in veterinary dosage forms like chewable tablets and soft chews provides unique benefits for manufacturers:

- Both Starch 1500® and StarCap® offer properties that can provide formulation solutions over a range of textural attributes.
- Unique particle size and shape of StarCap® provides texture and manufacturability to soft chews especially at medium and high active and oil loading.
- Starch 1500® and StarCap® exhibit good thermal stability, ideal for veterinary soft chew manufacture.
- Starch 1500® and StarCap® imparts plasticity (ductility) to soft chew dosage forms and helps maintain these properties over the shelf-life of the product.
- No animal products or by-products are used in the manufacture of Starch 1500® or StarCap®.
- No chemical additives or surfactants are used in the process giving a neutral taste with good palatability

References

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