Vitashure C™

Stabilized vitamin C for the animal and aquaculture industries

Balchem Corporation

www.balchem.com

Overview

Vitashure C is a feed stable, encapsulated source of vitamin C for the animal and aquaculture industries. Balchem’s proprietary barrier technology offers the best in stabilized vitamin C for optimum feed stability and animal and fish performance globally. Vitashure C offers constant feed stability and proven bioavailability by using Generally Recognized as Safe (GRAS approved), nutrient based, coating materials. Animals and fish can now realize the benefits of an antioxidant widely known to improve immunity, creating better stress and disease resistance in a product than can be top-dressed or added straight to the feed.

Product characteristics and performance

Composition

Vitashure C is manufactured using 100% pure ascorbic acid, comprising 70% of the total product. The remaining 30% is GRAS approved encapsulation material, consisting of hydrogenated vegetable oil. This creates a white to off white material of free flowing granules, that have a particle size specification of 2% maximum on a number 10 mesh screen (USSS).

Feed processing and storage stability

Vitashure C is designed to stabilize vitamin C through cold and steam pelleting conditions. In cold pelleting, there is essentially 100% retention of the vitamin C in Vitashure C through the processing and delivery conditions. In steam pelleting conditions, Vitashure C has been shown to have excellent stability (> 80%; Figure 1) through the pelleting process and the ability to have up to 180 days of shelf life depending upon the steam pelleting application. Extrusion conditions are much more severe than either cold or steam pelleting, and the current product form is not a strong fit for those applications, with less than 50% retention through extrusion conditions.

Bioavailability

Bioavailability of Vitashure C was accessed in the lab of Dr. Douglas Conklin at the University of California, Davis. In this work, Penaeid shrimp were fed increasing amounts of either raw ascorbic acid or Vitashure C to access the bioavailability of Vitashure C. Neither treatment was exposed to feed processing so as to prevent losses of the raw due to feed processing and the raw dosage was adjusted for leach rate in the water upon administration to obtain a true assessment of the performance of Vitashure C. By comparing tissue enrichment of ascorbic acid (Figure 2), it was determined that Vitashure C had the same bioavailability as the raw ascorbic acid. This is impressive considering the
relatively short length of the shrimp intestine, potentially limiting the time for
digestion of the lipid coating on Vitashure C.

**Aquaculture**
Ascorbic acid is required by fish, as they lack the ability to synthesize this vital
nutrient. Some ascorbic acid is provided by dietary ingredients, however,
supplemental ascorbic acid is generally required under most situations. In
supplementing ascorbic acid to fish, adjustments must be made to accommodate
the losses that occur during feed processing and storage, and also losses that
occur due to leaching of the ascorbic acid into the water. Chemically and
physically stabilized forms of ascorbic acid exist to deal with these losses of
ascorbic acid and are widely used in the industry.

The preferred form of ascorbic acid to use depends upon feed processing
conditions and to some extent, the specie fed. For cold pelleting diets, Vitashure
C, which is physically stabilized using high quality encapsulation technology is
preferred, as enzymes present in the feed matrix can cleave the phosphate
groups off chemically stabilized ascorbic acid, lowering its overall stability. For
steam pelleted diets, both technologies can be effective and comparable on a
cost in use basis. However, for species with short gastrointestinal tracts, such as
shrimp, Vitashure C has been shown to be completely bioavailable, where as
chemically stabilized ascorbic acid may not be completely available due to
incomplete cleavage of the phosphate esters off the ascorbic acid molecule. In
extruded feeds, chemically stabilized ascorbic acid is likely the preferred form, as
it is considerably more resistant to the processing conditions of extrusion than
Vitashure C. Target dosages differ by specie and life cycle stage, but often are
100 ppm.

**Swine**
Ascorbic acid is not an essential nutrient for swine. However, conditions may
exist in which supplementation may improve swine performance. Most of the
research is focusing on the role of ascorbic acid in immediately post-weaned
swine. Swine develop their ability to synthesize ascorbic acid gradually, and are
not completely developed until several weeks postweaning. Furthermore, higher
growth rates of contemporary animals along with more intensive rearing
regiments may result in proportionally greater ascorbic acid requirements for
young swine. Supplementation of ascorbic acid to the diets of postweaned swine
for the first several weeks postweaning has led to improvements in live weights,
gain and efficiency of gain in these animals.

The optimum dosage appears to be in the range of 50 to 75 ppm per pig per day,
although more work is ongoing to confirm this dosage. Encapsulated ascorbic
acid is recommended as raw ascorbic acid does not survive the steam pelleting
process adequately, and that is the typical process used in manufacturing swine
diets.
**Poultry**

Poultry is another specie that does not have a known requirement for ascorbic acid. However, young chicks and older hens appear to have incomplete synthetic capacity for ascorbic acid, making supplementation cost effective. In growing poultry, the primary response to increased ascorbic acid is improved bone strength. Currently, up to 15% of broilers and turkeys are lost due to weak bones. Ascorbic acid is involved in collagen formation, and supplementation has been shown to improve bone strength. In older hens, ascorbic acid can increase egg weight and shell strength.

Suggested dosages are 100 to 200 ppm for the first three weeks and for laying hens. Similar to swine, poultry feeds are largely steam pelleted, precluding the effective use of raw ascorbic acid in this application. Encapsulated ascorbic acid can nicely fit these processing conditions.

**Comparison versus competitive products/technologies**

Vitashure C will often be compared against other forms of stabilized ascorbic acid. The primary alternative technology to encapsulation is chemical stabilization of ascorbic acid phosphorylated sodium and calcium salts of ascorbic acid. The forms can be both as the monophosphate ester of L-ascorbic acid or the monophosphate ester with small amounts of di- and triphosphate esters. These products are water insoluble, resistant to feed processing conditions, and are approximately 35% to 40% ascorbic acid.

The ascorbic acid in chemically stabilized ascorbic acid is bioavailable provided the animal cleaves off the phosphate salts, a process that occurs readily in most species, but may not happen completely in all species, particularly those with short gastro-intestinal tract. Because these products are chemically stabilized, the product is still exposed to environmental conditions during storage and use, and may lose stability due to humidity, heat and light during storage if the packaging is not closed quickly and tightly after each use. Also, in feeds in which there are enzymatic activity present, such as cold pelleted feeds for aquaculture, environmental phosphorylase enzymes can destabilize the products rapidly, lowering the retention and supply to the animal/fish upon feeding.

Vitashure C is the product of choice for cold pelleted diets, as the enzymes in the feed matrix of cold pelleted feeds will cleave the phosphate esters of chemical stabilized ascorbic acid, dramatically lowering its stability. It will have comparable stability in most steam pelleting applications. However, chemical stabilized ascorbic acid is preferable to Vitashure C extruded diets.
Comparison of selected features of Vitashure C and chemically stabilized ascorbic acid.

<table>
<thead>
<tr>
<th>Item</th>
<th>Vitashure C™</th>
<th>Stay-C®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascorbic acid content, %</td>
<td>70</td>
<td>35 to 40</td>
</tr>
<tr>
<td>Stabilizing material</td>
<td>GRAS approved lipid encapsulate</td>
<td>Chemical stabilization with ester bound phosphate salts</td>
</tr>
<tr>
<td>Storage stability</td>
<td>Excellent, no practical concerns</td>
<td>Need to handle to avoid exposure to heat, humidity and light</td>
</tr>
<tr>
<td>Particle morphology</td>
<td>Free flowing granular material</td>
<td>Powder material</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Insoluble</td>
<td>Insoluble</td>
</tr>
</tbody>
</table>

**Value proposition**

The value proposition for Vitashure C has two main areas of emphasis. One is its relative cost in use comparison versus other product forms included raw ascorbic acid and competitive products, when adjusted for differences in ascorbic acid activity and stability in the intended application (Figure 3). The second is its cost/benefit ratio on generating a biological mode of action when used to create a desired biological effect, such as improved immunity and disease resistance.

In most feed applications, it makes little sense to use raw ascorbic acid, due to its relative instability during feed processing and storage and delivery in the feed to the animal at the time of feeding. The industry has long recognized the disadvantages of using raw ascorbic acid in processed feeds, and in general, has gone to using some form of stabilized vitamin C when ascorbic acid is used in animal diets. Stabilized vitamin C can take the form of coated ascorbic acid such as ethyl cellulose coated vitamin C, chemically stabilized vitamin C or a microencapsulated ascorbic acid like Vitashure C. All of these product forms have different advantages and disadvantages. In many instances, the differences between the product forms will come down to net retention versus cost per kg, or cost in use of the product adjusted for processing and storage losses.
Figure 1. Steam pelleting retention of ascorbic acid provided as raw ascorbic acid or Vitashure C™.

Vitamin C stability in pelleted diets

![Chart showing Vitamin C stability in pelleted diets](image-url)
Figure 2. Bioavailability of Vitashure C™ as tested in shrimp.
Figure 3. Cost/benefit of using Vitashure C™ in finished feeds.