A Novel Targeted Delivery Technology for Protecting Sensitive Bioactive Compounds During Long-Term Storage in Challenging Conditions

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Introduction:

Extending Viability Through Improved Protection and Stabilization

The inclusion of live probiotic bacteria in a typical non-refrigerated food product (~25°C and ~Aw>0.2) usually results in a rapid and significant loss of viability. Attempts to protect the bacteria through micro-encapsulation, including spray drying, extrusion, immobilization in calcium alginate beads, emulsion and top coating, have been utilized with limited success.

Here we report on a novel delivery technology (MicroMatrix™) designed to stabilize and protect sensitive bioactive compounds through food manufacturing processes and long-term non-refrigerated storage. The system utilizes several low molecular weight compounds that protect and stabilize the bacteria during the drying process and storage. These compounds include sugars, proteins, amino acids and polysaccharides (reviewed by Hubalek, 2003). The technology also involves a controlled desiccation process (Crowe et al., 1998) of a viscous formulation containing natural polymers surrounding the probiotic bacteria or other biologically active materials to be protected. As a result, the protected live probiotic bacteria remain quiescent while retaining their activity for a long period of time under challenging manufacturing, storage and gastric conditions. Storage stability of different species of Lacto and Bifido probiotic bacteria can be dramatically improved to less than one log loss of viability (<1 log CFU/g) after exposure to high temperature and relative humidity (37°C and 33%RH) for over three months.

This novel approach to stabilization, protection and delivery was successfully tested with various biologically active materials including probiotic bacteria, essential oils, vitamins, enzymes, pigments, and even vaccines in a variety of food and feed products. By adapting the technology to meet specific customer needs, MicroMatrix™ Targeted Delivery Systems enable the food industry to offer a wide range of new products containing sensitive bioactive compounds and probiotics outside the cold chain of distribution.

Methods:

Controlled Mixing and Milling

In one embodiment, the encapsulation system was composed of a proprietary mixture of polysaccharides, sugars and proteins. A viscous slurry of a bioactive ingredient and MicroMatrix™ components was prepared with controlled mixing. The material was vacuum dried under controlled temperature and pressure conditions that allowed for the development of an amorphous non-crystalline structure. The dry structure was then milled and the microparticles were sieved to deliver the desired particle size range.

Incubation:

Shelf storage conditions were emulated by incubating dry sample powders over saturated salt solutions in tightly closed desiccators. Storage stabilities under proscribed temperature and relative humidity conditions (37°C and 33% RH, for example) were determined by plate counting live

Results:

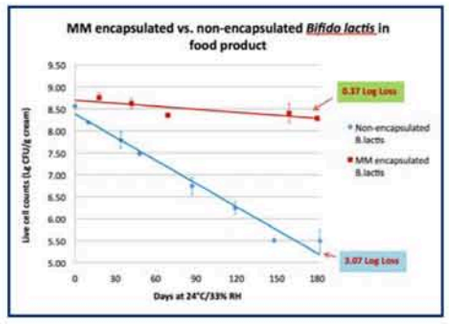

Fig. 1

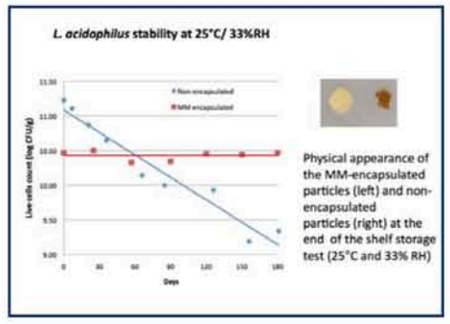

Fig. 2

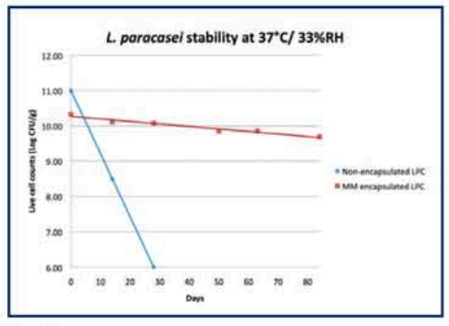

Fig. 3

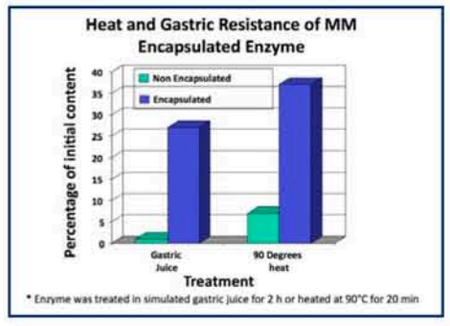

Fig. 4

Figures 1-3: ***Shelf storage stability tests of free and encapsulated probiotic bacteria (L. paracasei, Bifidobacterium lactis, and L. Acidophilus).*** Storage conditions were maintained constant at the temperature and relative humidity indicated on each graph. Results show a dramatic 1-9 order of magnitude improvement in shelf stability when encapsulated in the MicroMatrix™ system, alone or in food product.

Figure 4: MicroMatrix™ is effective in protecting enzymes, too. Subjected to simulated gastric juice for 2 hours, or exposed to 90°C for 20 minutes, the MicroMatrix™ encapsulated enzymes showed dramatically improved stability.

Conclusions:

- Shelf-storage stability of MicroMatrix™ encapsulated probiotic bacteria improved significantly compared to free bacteria.
- A significant stability was achieved even under relatively high humidity exposure (43% RH).
- MicroMatrix™ can be effectively targeted to post-gastric delivery.
- MicroMatrix™ can protect sensitive bioactive materials (enzymes, pigments, vitamins, essential oils) from oxidation and heat exposure.
- MicroMatrix™ technology allows the application of sensitive bioactive compounds to a wide range of new food and feed products outside.

Acknowledgements:

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