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International Workshop BIOENCAPSULATION VI

From fundamentals to industrial applications

High pressure encapsulation technology and the development of functional ingredients from surplus milkfat

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Microencapsulation techniques have been used to resolve a critical storage need with the development of functional powders having novel properties. Surpluses of milkfat had increased in U.S. government stocks because of continuing consumer concerns about the fat and cholesterol contents of their diets. Spray dried powders containing 50% milkfat were prepared by encapsulation in a variety of carbohydrate matrices. SEM studies revealed a unique mode of encapsulation for powders prepared with sucrose as the encapsulant. Powders contained microcavities, and no central vacuoles. Through an additional high pressure encapsulation process, a high-melting waxy second coat was applied, which improved moisture barrier properties.

Introduction

Bioactive additives and nutraceuticals or pharmafoods are emerging areas for microencapsulation technology (Jackson and Lee, 1991; Duxbury and Swientek, 1992). Encapsulation is an avenue for protecting sensitive matrices from moisture uptake, oxidative deterioration and exposure to light, which also improves quality.

Double encapsulation creates an added barrier which, depending on choice of the second coat, will enhance delivery of the functional content (Pothakamury and Barbosa-Canovas, 1995). This is essential for controlled release in foods, an aspect that is becoming increasingly basic in functional powders. We describe some physical characteristics of the double coated powders containing milkfat and moisture sorption properties of the spray dried microcapsules.

Method of Manufacture

Single encapsulated powders were formulated to have 50% butteroil, 5% emulsifier, and 5% skim milk powder with the remainder encapsulant. Moisture content of the spray dried encapsulated powders ranged from 1-4 %. The processing sequence for the single capsule has been described previously (Onwulata et al., 1994). Double encapsulation was done with the application of a mixture of vegetable waxes (hydrogenated stearines), Sterotex NF® (Abitec Corp. Columbus, OH) and food grade linear polymeric alcohol polymers, Unilin 350® (Petrolite, Tulsa, OK) at a 99:1; Sterotex to Unilin ratio. The waxes were melted at 105°C and Beta® treated (Encapsulation Systems Inc., Sharon Hills, PA). The process and the M-CAP® device used for double encapsulation have been reported (Redding 1990; Redding 1993). The process is shown in Figure 1.

Microstructure

The topography of intact and fractured particles examined by secondary electron imaging using a scanning electron microscope (Model 840A, JEOL, USA, Peabody, MA), has been described previously (Onwulata et al, 1996). Topographical features of the single and double encapsulated powders were evaluated by scanning electron microscopy. SEM images of single encapsulated powders show that the surfaces of the powder particles have irregular ridges with ovoid dimpling, and the particles are somewhat agglomerated. In contrast, the surfaces of double encapsulated powder particles are very smooth. The fractured particle shows the enclosure of the single encapsulated particle within the double capsule. The mode of double encapsulation is depicted in Figure 2. Either a single large particle (A) or several smaller particles (B) are encased within the matrix of the double encapsulated powder (C). Therefore, a double coated powder could either be a simple powder, or a compound powder with more than one particle being encapsulated. There are several possibilities with double encapsulated powders, especially considering the large number of compounds that could be used as the second coat.

Figure 1. Schematic illustration of the single and double encapsulation

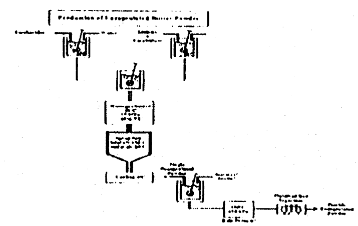
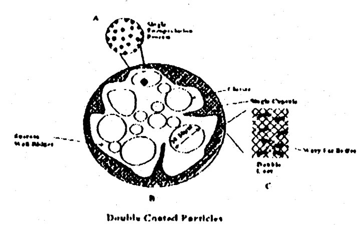


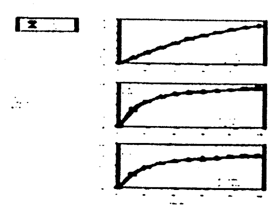
Figure 2. Illustration of the double encapsulated powder

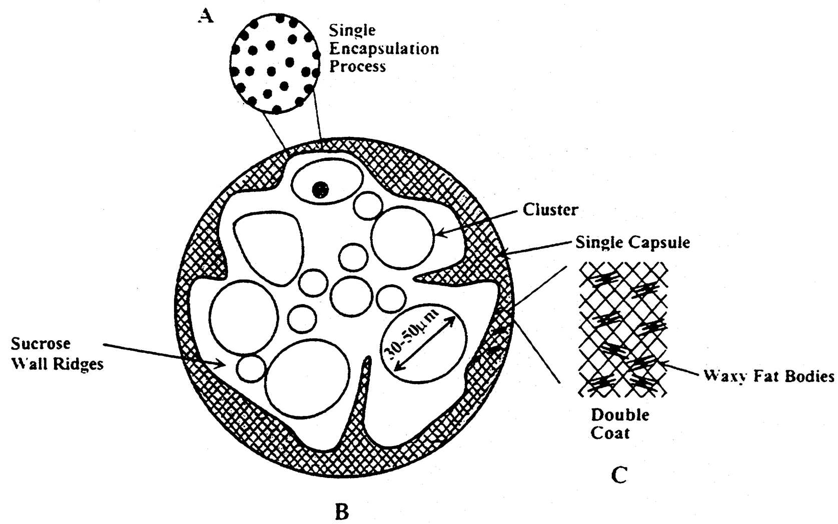


Moisture Sorption Properties

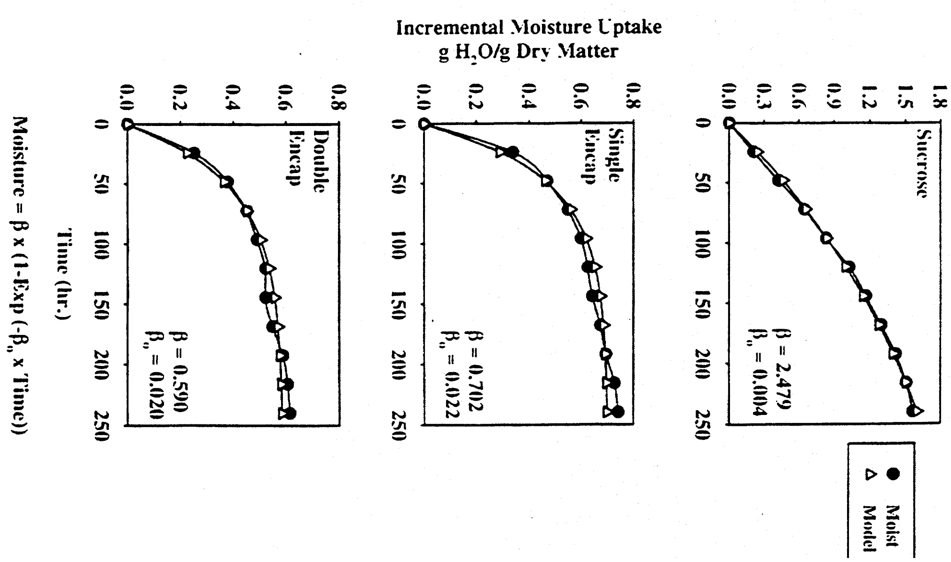
Moisture sorption isotherms were obtained at 25°C by equilibrating 10-g powder samples with known water vapor pressures provided by saturated salt solutions at 52% relative humidity. Sorption isotherms of powders with 50% butteroil encapsulated in sucrose are presented in Figure 3. The moisture uptake for all powders fit an exponential function, the rate of uptake being dependent on the powder and the exposure conditions. Further reduction in moisture uptake is shown with the double encapsulated powder. In terms of moisture sorption or as a moisture barrier, the double encapsulated powder is more efficient. This functionality enhances the benefits of encapsulation, and could possibly ameliorate or eliminate the need for special packaging to prevent moisture imbibition during storage (Onwulata and Holsinger, 1995).

Figure 3. Sorption isotherms of single and double encapsulated powders





Double Coated Particles



Benefits of the Technology

Double encapsulated powders have properties that differ significantly from those of the single encapsulated powders or those of crystalline sucrose. Large particle size, lower density and increased wax on the surface impedes powder flow. However, the double encapsulated powders have superior resistance to moisture sorption. Through choice of wall material, such as sucrose, and powder preparation methods described here, an effective carrier for sensitive ingredients may be realized. Spray dried encapsulated milkfat powder shows great potential for use as a food ingredient in such products as dry bakery mixes, confectionery and novel microwave products. Moisture uptake and sorption isotherms are correlated with type of encapsulant for single encapsulated powders, which need special packaging to prevent moisture imbibition during storage. However, double encapsulated powders with reduced moisture sorption may reduce the need for special packaging.

Acknowledgments

The authors thank Drs. John Phillips for assistance with the experimental design, and Peter Cooke for microscopy.

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