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Microencapsulation: Applications in the Different Dairy Products

Suchita Bhosale[1] , R.J.Desale[2,] and Y.G.Fulpagare[3]
[1]*Department of Animal Husbandary and Dairy Science, Post Graduate Institute, M.P.K.V.Rahuri.Dist-Ahmednagar, Maharashtra, India*
[2] *Associate Professor,* [3] *Head Department of Animal Husbandry and Dairy Science*
[2,3]*Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra*

Abstract - *Dairy and food industries are in a major technological and sociological revolution. There is no better example than dramatic changes occur in the availability of various products and consumer choice. There are various types of encapsulation technologies that can be employed in the food industry. The use of different encapsulation technologies for the protection of health ingredients achieved high ingredient efficiency. Microencapsulation is defined as a technology of packing solids, liquids, or gaseous materials in miniature, sealed capsules that can release their contents at controlled rates under specific conditions. The advantages of microencapsulation and nanotechnology have opened up new opportunities that can revolutionize dairy products processing. The present paper reviews the emerging trend and some of the potential applications of encapsulation technique in the field of agriculture with a precise exceptional pivot towards dairy science research interventions*

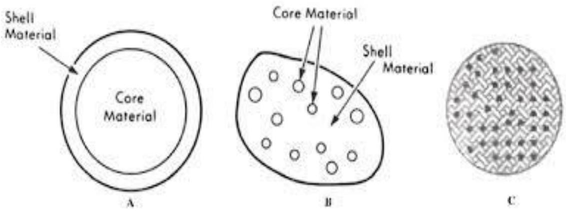
Keywords - *Nanotechnology, Microencapsulation, Nutraceuticals, Bioavailability, Viability*

Introduction

. Now a day, the Dairy and food industries are in a major technological and sociological revolution. There is no better example than dramatic changes occur in the availability of various products and consumer choice. Consumers demand fresh, genuine, convenient, and flavorful food commodities. To get the benefit and to maintain leadership in the food and food processing industry, novel frontline technology is required. Among all novel frontline technology, nanotechnology has earned much attraction in the Dairy and meat industry. Nanotechnology can assist a wide field of the food processing area. The function of nanotechnology in food processing is generally on food preservation and interactive foods. Nanoparticles can be incorporated into existing food to deliver nutrients, increased the absorption of nutrients by the body, and also could increase product shelf life. The advantages of nanotechnology in food processing are to develop the texture of food components, encapsulate food components or additives, developing new tastes and sensations, controlling the release of flavors, and increasing the bioavailability of nutritional components. There are various types of encapsulation technologies that can be employed in the food industry. The use of different encapsulation technologies for the protection of health ingredients achieved high ingredient efficiency. It not only depends on developing or choosing the right encapsulation technique but also requires expertise in food processing.

WHAT IS MICROENCAPSULATION?

What is Microencapsulation?
Microencapsulation is defined as a technology of packing solids, liquids, or gaseous materials in miniature, sealed capsules that can release their contents at controlled rates under specific conditions. The product obtained by this process is called a microcapsule/microsphere. This is of two types: Microcapsule (particles diameter 3-800um), Macrocapsule (Larger than 1000um).



Coated material called core material, active fill / internal phase. The coating material can be a capsule/shell. (Mozafari *et* .al. 2007). The encapsulating agent should have certain ideal characteristics depending on objectives and requirements, the process of encapsulation, chemical characteristics of the core material.

Some general characteristics of the encapsulating agents are that it is insoluble in and non-reactive with the core material, has a solubility in the end product food system, and be able to withstand high-temperature processing. Some typical encapsulation agents are dextrans, gums, starches, and proteins.

Coating materials for encapsulation:

Class of coating materials	**Specific types of coatings**
Gums	Agar, Sodium alginate
Carbohydrates	Starch, sucrose, dextrin

Cellulose	CMC,ethylcellulose,acetylcellulose
Lipids	Wax, stearic acid, fats, beeswax
Proteins	Casein ,gelatin ,albumin

[7]

Reasons for Encapsulation:

- Protection
- Convert liquid active components into a dry solid
- Create new functional food
- To increase bioavailability
- Control release of the active components for delayed release
- Increase acceptability

Numerous encapsulation techniques have been developed on micro- and nanoscales. In general, three steps are involved in the encapsulation of bioactive agents: formation of the wall around the material to be encapsulated; ensuring that undesired leakage does not occur; and ensuring that undesired materials are kept out.

The encapsulation techniques are as below;

Technique	Major steps
1.Liposomes/Nanoliposomes	a. Micro-fluidization b. Sonication c. French pressure cell: extrusion
2.Spray- cooling	a. Preparation of the dispersion b. Homogenization of the dispersion c. Atomization of the infeed dispersion
3.Spray – drying	a.Preparation of the dispersion b.Homogenization of the dispersion c.Atomization of the infeed dispersion d.Dehydration of the atomized particles
4.Extrusion	a.Preparation of the molten coating solution b.Dispersion of the core into the molten polymer c.Cooling or passing of core coat mixture through dehydrating liquid
5.Fluidized-bed coating	a.Preparation of the coating solution b.Fluidization of core particles c.Coating of core particles
6. Coacervation	a.Formation of a three – immiscible chemical phases b. Deposition of the coating c. Solidification of the coating
7.Spray –chilling	a.Preparation of the dispersion b.Homogenization of the dispersion c.Atomization of the infeed dispersion
8.Centrifugal extrusion	a.Preparation of the core solution b.Preparation of coating material solution c.Co-extrsion of core and coat solution through nozzles
9.Lyophillization	a.Mixing of core in a coating solution b.Freeze-drying of the mixture
10.Inclusion complexation	Preparation of complexes by mixing or grinding or spray-drying

[7]

Microencapsulated Dairy products;

a) MILK: Milk microencapsulated with different nutraceutical ingredients

Functional ingredients	Study	Impact
1.Chitosan *[1]*	The incorporation of microencapsulated chitooligosaccharide into milk by using polyglycerol monostearate (PGMS) as a coating material	Health-promoting function, Used as a functional food ingredients
2.Isoflavone *[3]*	Microencapsulated isoflavone added to milk by entrapping chitosan particles	A significant role in lowering blood cholesterol

	with medium-chain triglycerides (MCT) as the coating material.	level
3.CLA(Conjugated linoleic acid) [4]	WPC has been an effective coating material to prevent the oxidative deterioration of CLA.	CLA having health function as being anticarcinogenic effect.
4.Peanut sprout extract *[6]*	The study demonstrated that the concentration of peanut sprouts extract microcapsules (PPSEM) of up to 0.1% could be used in formulating functional milk.	Anti-aging, Anti-inflammatory and anticarcinogenic properties

b) MILK WITH IRON:

Microencapsulation of Milk with Iron. *[6]*

Milk and dairy products are being considered as suitable iron-fortifying vehicles due to their high consumption and as an outstanding source of essential nutrients. Moreover, milk is well known for its low content of iron (0.2 mg/kg), despite being abundant with other nutritional elements. Therefore, the fortification of milk with iron could be an important solution in the fight against iron deficiencies. For a feasible iron fortification in milk, microencapsulation of iron salts has begun using a type of phospholipid called SFE-171 as a coating material. [6]

Iron is an essential microelement and has several important functions in the human body. Lack of this element leads to one of the most prevalent nutritional deficiencies around the world called iron deficiency anemia (IDA) which affects nearly 20% of the world's population.

c) FLAVOURED MILK

Application of microencapsulation technology for the production of Vit –C fortified Flavoured Milk

Aim	Result	Importance
To develop flavored milk with standardized Vit-C microcapsule & storage stability of Vit-C fortified flavored milk	1. Study revealed the use of microencapsulation technologies for the protection of health as achieved through high ingredient efficiency. 2. The outcome of the study pointed out the possibility to stabilize the vitamin-C in flavored milk by using microcapsules for even more than one-month storage at room temperature. 3. The study also envisaged the need for replacing the costly vitamin-C powder with an alternate natural source and fortified in some other dairy products.	1. Vitamins and minerals fortification has been used to improve the nutrient content of foods. 2.Many vitamins are relatively unstable and their activity in foods depends on pH and their stability to heat, light, oxygen, oxidizing agents and enzymes 3.Encapsulation of vitamin-C provides higher shelf life. Stable vitamin-C shall be a good asset to fortify with foods.

[10]

d) ICE CREAM Enhancement of probiotic viability in ice cream by microencapsulation

Aim	Results	Importance
To evaluate the survivability of two proven probiotic strains viz., Lactobacillus acidophilus (LA-5) and Lactobacillus casei (NCDC-298) in ice cream using microencapsulation technique.	1. Probiotic survivability in ice cream can significantly be improved by microencapsulation. 2. High fat and solids content of ice cream and other frozen desserts may protect the probiotic bacteria and serve as the carrier for delivering the probiotic bacteria into the human gut. 3.In all types of ice cream the number of the viable probiotic bacterial count was between 10^8 and 10^9 cfu/g at the end of three months of storage which is the normal shelf life of ice cream.	1. Probiotic dairy products is a key research priority for food design and a challenge for both industry and science sectors. 2. Nutritional and physiological benefits of probiotic foods are the promotion of growth and digestion, setting effect on the gastrointestinal tract, improving bowel movement, suppression of cancer, catering to lactose intolerance, and lowering blood cholesterol level etc.

[5]

e) FETA CHEESE

Chemical composition and sensory characteristics of Feta cheese fortified with iron and ascorbic acid

Aim	Result	Importance
1. To investigate the effect of iron fortification on the quality of Feta cheese. (Cheese sample-cow milk Fortified with- Iron compounds - ferrous sulfate ($FeSO_4$), ferric chloride ($FeCl_3$), and microencapsulated ferrous sulfate at the level of 80 $mg.kg^{-1}$ with or without L-ascorbic)	1.Study demonstrated that fortification of cheese with 80 $mg.kg^{-1}$ microencapsulated iron and 150 $mg.kg^{-1}$L-ascorbic acids is technically feasible with only a small increase in lipid oxidation, measured by TBA value. 2. No off-flavor was detected by trained sensory panelists. Ascorbic acid showed a promising impact on reducing the unfavorable effects of iron.	1.Feta cheese is one of the most popular soft cheese, with high worldwide consumption is an excellent source of calcium and protein, but as a typical dairy product, it contains a very low amount of iron. 2.Therefore, fortification of cheese with iron would help to meet this nutritional need.

[2]

6. **YOGHURT**

Fortification of Microencapsulated Iron in Yoghurt

1To develop microencapsulated whey protein-chelated iron (Fe-wp) using ferrous sulfate as the iron source by emulsion method employing sodium alginate as the wall material that could be used in the development of iron-fortified yogurt.	1. Fortified iron did not affect the viability of *Lactobacillus delbrueckii ssp. bulgaricus* and *Streptococcus salivarius* ssp. *thermophilus* in yogurt. 2. Indicated that iron can be fortified only up to 20mg per liter in unencapsulated form, while in the form of microencapsulated iron it can be incorporated up to 80 mg per liter of yogurt using ferrous sulfate without affecting the accepted appearance, sensorial and textural attributes of yogurt.	1. Iron deficiency anemia is still the most prevalent nutritional problem, which affects 30% of the world"s population. 2. Iron deficiency anemia affects 60 % of Asian women of reproductive age and 40 to 50 % of children enrolled in preschool and primary grades 3.Fortification of dairy foods to obtain the recommended daily dietary allowances for iron (10- 15 mg for adults) is one of the most effective solutions

[9]

CONCLUSIONS

Microencapsulation is no longer just an added value technique, but the source of totally new ingredients with matchless properties and can be applied in the development of new and novel functional foods. It is only one of a suite of technologies that may be applied to enhance the quality of healthy dairy foods and its suitability depends on the food product to be fortified, the need for protection of food components, and timed release of nutraceuticals.

The advantages of microencapsulation and nanotechnology have opened up new opportunities that can revolutionize dairy product processing. Based on recent research, it is worth noting that some of the inventions are not only suitable for small scale processing but also are potential candidates for commercial applications. Research regarding the application of nanotechnology in dairy products is still in infancy, yet a few of the studies show great potential for the dairy industry.

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