

# Application of “Big Data” Based Liposomes in Food and in Vitro Digestion

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**Abstract:** The article introduces the “big data” based liposome technology and its latest research progress and application in the food industry. The liposome acts as a protective carrier for new dosage forms or sensitive components, and constructs a food enzyme microcapsule reactor as a sustained release carrier for special food components. Because of its characteristics of protection, transportation, targeting and sustained release, it has shown great application potential in food nutrition, medicine, cosmetics and agriculture. In this paper, the properties and characteristics of liposomes were briefly introduced. The structure of liposomes remained stable during simulated human gastric digestion alone, while the changes of liposomes were easily oxidized by trypsin and bile salt in simulated small intestinal environment. The research progress of liposome as a carrier system of food nutrient factors in simulating gastrointestinal digestion in vitro was briefly summarized.

## 1. Introduction

Liposomes are bilayer closed vesicles composed of amphiphilic substances such as phospholipids and having a cell-like membrane structure. The lipid-based carrier system can be divided into two types, one consisting of simple oils and fats. The other type is formed by self-dispersion by oil phase, water phase, surfactant and co-surfactant [1]. Liposomes can be prepared from naturally occurring or synthetic phospholipids as raw materials, which have the advantages of protection, targeting, long-acting, non-toxic, etc., and the process is relatively simple, easy to expand production, and diversified supply routes. Liposomes range in size from tens of nanometers to tens of micrometers in diameter, and can entrap multiple substances in the aqueous phase and membrane of liposomes [2]. With the rise of big data technology, the big data concept provides us with a new way of looking at the world, no longer relying entirely on random sampling, no longer keen on pursuing precision, and no longer keen to find causality. Through the use of these computer data technology, food enterprises can control food safety problems to the greatest extent in the process of large data management. The oxidation of phospholipids in liposomes mainly acts on the polyunsaturated phosphatidyl chains, and is affected by the saturation of fatty acid chains in phospholipids and the ionic strength in solution [3]. Therefore, this paper reviews the research status of liposomes in the field of food, and summarizes the research progress of liposomes in simulated gastrointestinal digestion in vitro, which provides certain information and basis for expanding the application of liposomes in the field of food and the study of liposome digestion.

## 2. Introduction of Liposomes

Liposomes are self-assemblies of lipid molecules. Liposomes have one or more lipid bilayer tundra-coated microaqueous phases with biofilm-like structures, which can be either naturally present or synthesized. Liposomes are a widely studied delivery system [4]. Liposomes in low acid environment, such as gastric acid, are more prone to oxidative reactions. The products contain negatively charged fatty acids and other substances, which directly affect the encapsulation efficiency of liposomes. In the traditional food industry, liposome microencapsulation technology is mainly applied to the encapsulation of enzymes, flavor components, vitamins, minerals and other sensitive components in the dairy industry. The formation mechanism of liposomes has not yet been fully determined. The most representative viewpoint is based on the interaction between

amphiphilic compounds (mainly phospholipids) and water molecules. The hydrophilic head of phospholipids is located on the inner and outer surface of the membrane [5]. The difference between big data and past massive data is not only because of the large amount of data, but also because of the large number of data types, low value density, fast processing speed and high timeliness requirements. Big data is fundamentally different from traditional data mining. Big data is a collection of data that is so large and complex that it becomes difficult to use the database management tools at hand or traditional data processing applications. With the development of liposome technology combined with the unique structural properties and physicochemical variability of liposomes, researchers began to modify traditional liposomes, and many new liposomes appeared [6]. Liposomes as an oral delivery system, its greatest value is the protection, controlled release, targeting and bioavailability of the embedded material during gastrointestinal digestion. In recent years, liposomes have been used in the gastrointestinal tract. The study of digestive digestion has become a frontier.

### **3. Study on Liposome in Food**

#### **3.1 Liposome-encapsulated lipids**

Lipids such as DHA, eicosapentaenoic acid (EPA) and essential oil contain unsaturated bonds, which are easily oxidized and destroyed by light. Metal ions or heat can accelerate their decomposition. The earliest application of liposomes in nutrition was inspired by breast milk. In recent electron microscopic studies of breast milk, lipid bubbles (liposomes) have been found. Through the analysis of sales data, we can understand customer shopping habits, segment customer groups, and provide personalized services. It can maintain or restore the properties of physiological membranes, enhance the fluidity of cell membranes, promote the secretion of N-terminal amyloid precursor protein fragments, and thus improve the survival rate of neurons. The particle size of liposomes is generally in the order of nanometer, which can be observed under a thousand-fold optical microscope. The particle size and particle size distribution of liposomes can be roughly measured by optical microscopy and electron microscopy. The liposome-encapsulated rosemary leaf distilled essential oil and the thyme leaf distilled essential oil were prepared by membrane dispersion combined with ultrasonic method. The result showed that the liposome could play a good role in the protection of food and meat. Oral insulin generally has only a very low bioavailability, but liposomes provide a protective layer for insulin molecules [7]. Other studies have shown that drug molecules in the form of liposomes can penetrate cell membranes more efficiently [8]. Therefore, in order to make big data play a role in the theoretical data analysis of insulin molecules, the collection and sharing of data is the key to the problem.

#### **3.2 Antioxidants embedded in liposomes**

Encapsulation of antioxidants by delivery technologies such as liposomes is one of the most in-depth and widely used directions in the food industry. Using image analysis method to determine the morphological parameters of liposomes can not only accurately measure the size and distribution of the particles, but also the morphological factors and distribution of the particles. This method has little influence on the liposomes and the results are more accurate. In the liposomes composed of the same lipid, the gel has different adsorption properties for different drugs with similar properties, and the conditions of use must be examined before use. The particle size of the liposomes was less than 115 nm, and the physical stability of the liposomes was good. The content of hexanal produced by the liposomes after storage for 120 days was significantly lower than that of polyphenols not encapsulated in the liposomes. At present, most of the data obtained through the sampling monitoring of the existing system has not been transformed into an information service platform directly provided to the people. If the conversion is realized, the amount of data generated will be larger. Data is a big data management object, and data can generate new applications and information services, resulting in commercial and social benefits. Studies have confirmed that autoimmune liposomes based on different types of analysis systems are low in cost and accurate in

results, and can routinely screen a large number of samples for food pathogens within 2 hours. After the liposome of the sodium methotrexate salt is prepared into a suspension, the method of freeze-drying and cryopreservation is used, and the leakage of the drug is greatly reduced compared with the room temperature.

### 3.3 Liposome-encapsulated proteins and enzymes

Liposomes coated proteins and peptides are another important research direction of food-grade liposomes. Many components in the blood have a destructive effect on liposomes, such as high-density fat-soluble proteins, complement systems, serum albumin, phospholipases, and the like. The free drug penetrates the concentration gradient from the dialysis bag out of the dialysis bag, and the liposome cannot penetrate into the external medium due to the large particle size. Studies have shown that under the encapsulation of liposomes, the protection of lactoferrin is achieved, so as to avoid the influence of pepsin in the digestion of gastric juice, so that it can be digested and absorbed in the small intestine, thereby achieving the characteristics of controlled release and improving lactoferrin. Protein utilization. The core of the application and processing of large data still needs scientific planning from the business level. Not all information is useful in massive data. Use directions clearly. How to collect and organize these data? If these data can not be shared, it can not produce information value-added. Studies have shown that liposomes do not affect the water activity and microorganisms of cheese, but can reduce the whey loss of acellular extract organisms and maximize the maturation of cheese. It is feasible to substitute phytosterols for cholesterol in the preparation of liposomes. The use of phytosterols instead of cholesterol as liposome membranes with cholesterol-lowering effect will help to broaden the application of liposomes in food and pharmaceutical industries.

## 4. Study on in Vitro Digestion of Liposomes

In recent years, it has been found that besides the selection of core materials and the optimization of preparation process, the structural stability of digestive tract and the interaction mechanism with other dietary ingredients or gastrointestinal mucosal cells have a great impact on the performance of food-grade liposomes. Colloidal chemical properties of liposomes, especially surface chemical characteristics, are the key to control the high efficiency and safety of liposomes. Polymerization chain reaction on the surface of liposomes has been proved to be the source of many effects of liposomes. Cation exchange resin has no adsorption on liposomes, and all free drugs are adsorbed to achieve the complete separation of liposomes and free drugs. The entrapment efficiency is determined by first derivative spectrophotometry. Coarse liposomes and nano-liposomes were prepared by thin film dispersion and dynamic high pressure micro-jet technology respectively. The results showed that the physical and chemical properties of liposomes were less affected by pepsinase in simulated gastric juice digestion, while the phospholipid wall of liposomes was greatly damaged in simulated small intestine digestion. However, as the digestion time in the stomach continued to digest in the simulated small intestine, the average lipid peroxide value showed a significant downward trend, indicating that the simulated gastric digestion process affects the degree of oxidation of the liposome in the simulated small intestine. Infant and adult simulated gastrointestinal digestive juice preparation of simulated gastric and intestinal fluid preparation methods are improved with reference to relevant research results. Table 1 below shows the simulated gastrointestinal digestive formula for infants and adults.

Table 1 Infant and adult simulated gastrointestinal digestive formula

In vitro digestive juice model	Simulated infant gastric juice	Simulated adult gastric juice	Simulated infant small intestine	Simulated adult small intestine
PH	2	1.2	7.5	7.3
Pepsin( mg/m L)	0.6	3.3	0.1	0.6
Pancreatin( mg/m L)	0.1	0.5	0.23	2.3
Cholate( mg/m L)	0.3	0.4	1.4	5.1

At present, many literatures have reported that the encapsulation characteristics of liposomes can be expressed by the determination of drug-lipid ratio after the separation of free drugs. Liposomes can not achieve long-term effects if they are quickly recognized and ingested by cells of the reticuloendothelial system. The preparation of polymer liposomes based on chitosan polyelectrolyte modified liposomes has higher embedding rate and stronger sustained-release function than traditional unmodified liposomes, and the release in vitro simulated gastrointestinal tract depends on the pH value of the release medium. In addition, some studies have shown that the lipid oxidation rate decreases with the increase of pH between 3 and 6. Using the different displacement of resonance signals of free drugs and encapsulated drugs at different pH values, the encapsulated and uncapsulated drug peaks were identified and the encapsulation efficiency of liposomes was determined. Covering the hydrophobic binding site on the surface of the liposome, hindering the plasma component from approaching the liposome, thereby reducing the recognition and uptake of the reticuloendothelial system and prolonging the circulation time of the liposome in the blood. The content of protease in the stomach is small, the damage of liposome is small, and the probability of contact between the dissolved oxygen and water-soluble free radicals in the system and the fatty acid chain is lowered. After studying its physicochemical stability and in vitro digestion stability, it was found that the polyelectrolyte on the surface of the liposome can enhance the ionic and thermal stability of the liposome through steric hindrance, and the liposome can be further digested in the gastrointestinal tract. Effectively prevent leakage of the core material. The analysis of the degree of oxidation of liposome in simulated gastric digestion by Figure 1 revealed that the lipid peroxide value did not change significantly with the increase of digestion time in the adult group or the infant group, and it slightly increased first and then decreased.

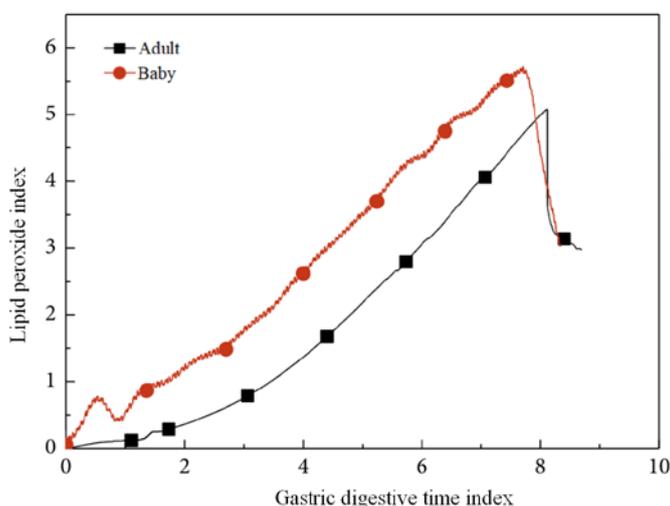


Fig.1. Changes in Lipid Peroxide Values in Liposomes during Simulated Digestion in Infants and Adults

The integrity of the liposome bilayer membrane in the blood is a key factor in ensuring that the liposome interacts with intravascular or extravascular target cells and acts as a drug carrier. According to the microcolumn centrifugation method, the properties of some free drugs and liposomes cannot be completely separated, and the free drug is separated first, and then the ratio of drug to lipid is determined (the amount of phospholipid is determined by the phosphorus method) to determine the encapsulation of the liposome. rate. At present, there are few studies on the transport systems (including liposomes) based on edible lipid wall materials in different populations, especially the lack of scientific understanding of the structural changes of liposome digestion and the release regulation of inclusions in special populations. This requires the construction of a unified data center, centralized management of basic data to facilitate data mining and data analysis for large data in the later period. Big data management is helpful to establish a comprehensive and three-dimensional food supervision information system, which integrates production, management, consumption and other data into the system, and extracts relevant information through integrated

retrieval, utilization and analysis to meet various regulatory needs. The targeting of liposomes can be divided into passive targeting and active targeting. Passive targeting is the natural distribution of liposomes after they enter human body. Good intravenous injection of liposomes mainly locates in liver, spleen, bone marrow, macrophages in blood, etc. Liposomes exhibit more intense lipid oxidation and more obvious changes in the simulated continuous gastrointestinal digestion, possibly due to the high pepsin content in simulated adult gastric juice.

## 5. Conclusion

There are many methods for determining the encapsulation efficiency of liposomes, but not every method is suitable for all liposomes. Therefore, when examining the encapsulation efficiency of liposomes, only the appropriate measurement method can be selected by theory and experiment. The encapsulation efficiency is more meaningful. By the intersection of physical chemistry, microbiology, pharmacokinetics and other disciplines, the relationship between food-grade liposomes and other components, liposome structure and functional properties is established. The development of more and newer food delivery systems will bring new opportunities. For small and medium-sized enterprises, most of them do not have the consciousness of using computer data technology in enterprise management. Therefore, it is necessary to publicize the importance of computer data technology in enterprise management. The gastrointestinal tract is the main digestion and absorption site of nutrients. The lipid oxidation level in the simulated intestine and stomach is measured. It can not only judge the stability of liposomes in gastrointestinal digestion, but also evaluate the production of peroxide after continuous gastrointestinal digestion.

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