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The Feasibility of Industrial Production of Lipases with an Emphasis on Its Applications in Food Enrichment

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ABSTRACT

Background: Lipases are the most flexible biocatalysts and they catalyzes Bioconversion reactions wide range. These enzymes have beneficial effects on food substrates such as natural oils, synthetic triglycerides and fatty acids. Lipases are used in a wide range of modern biotechnology industries, such as the synthesis of biopolymers, biodiesel and the pharmaceutical industry in addition use in the food industry about to enrich the omega-3 fatty acid (Docosa hexaenoic acid) in soybean oil, processing of fats, dairy products and the development of food biosensors. **Methods:** Online databases such as PubMed, Scopus, ISI Web of Science, Google Scholar were searched without any restrictions. **Results:** The results of these studies show that due to the extraordinary potential of lipase In the food and medicine industry, codification a strategic plan in the country, To develop mass production technologies for these enzymes and Practical steps, It seems necessary in their use in essential food enrichment. **Conclusions:** Characteristics of the use of lipase catalytic reactions have a significant commercial potential in industrial biotechnology. The production of these enzymes in the industry has a significant commercial potential in industrial biotechnology.

Keywords: *Lipase; Triglyceride; Lipase applications; Food industry*

Lipases are enzymes that are present everywhere, including plants, fungi and bacteria and have significant physiological and industrial potential. Biological function of lipase is the catalyzed hydrolysis of triacyl glycerol to free fatty acid, diacyl glycerol, monoacyl glycerol and glycerol. Lipases have unique properties against aqueous and non-aqueous environments. When the content of the ambient water is low, the synthesis of ester is made from glycerol and long chain fatty acids. A true lipase separates the emulsions of glycerin esters from long chain fatty acids, such as tripalmitin and triolein. The chemical development of enzymes has been

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promising in the last 33 years, especially in the food industry (Xu, 2000).

Lipases have a wide range of applications in detergents, organic industries, leather industry, environmental management, cosmetics and perfume industries, medical materials and biomaterials. Currently, lipases are utilized to produce enantiomers of enriched primary and secondary alcohols. Nevertheless, it is less used for chiral carboxylic acids and secondary amines. Small esters and short chain carboxylic acids and half of the lipase-synthesized alcohols play an important role in the food industry, such as flavor and aroma. Enzymatic esterification is used by lipases to block intermittent chemical pathways (Jaeger and Eggert, 2002). Transesterification is a method for modifying oils and fats. This activity is provided by fixation of the enzyme on a solid matrix surface such as celite. Transesterification of catalyzed lipase is related to the properties of the enzyme itself, which provides a precise control over the addition of the desired fatty acid in the position of the specific glycerol (Khare and Nakajima, 2000).

The synthesis of esters using lipases can be performed at room temperature, with proper pressure and pH. The products obtained by these methods are purer compared to the products obtained by alternative chemical methods because the chemical catalysis often leads to the creation of non-specific and unwanted products. It also requires a higher temperature, higher pressure, and alternative catalyst recovery. The use of lipases decreases the downstream processes. Therefore, it reduces the overall cost of the process. However, the main problem with this system is low conversion in comparison to chemical processes. Lipases are produced by several microorganisms, including bacteria, fungi, archaea, eukaryotes and also by animals and plants. From a commercial point of view, useful lipases typically result from microorganisms that produce artificial varieties of extracellular lipase. Microbial lipases are more attractive due to persistence in organic solvents, lack of cofactors and different substrate characteristics. The first commercial recombinant commercial lipase was derived from *Thermomyces lanuginosus* (formerly known as *Humicola lanuginosus*) and expressed in *Aspergillus oryzae* (Sharma *et al.*, 2001).

Microbial sources of lipase production

Lipases are widely used in different industrial fields. These enzymes are produced from fungi, molds, or bacteria, and are often secreted in an extracellular manner. In the meantime, microbial lipases are commercially important in terms of low production costs and higher sustainability. The very high potential of biotechnology for microbial lipases is in relation to chemical selection, selectivity of regions, and spatial selectivity of lipases, because some of them can be produced in high amounts from microorganisms (Treichel *et al.*, 2010). In the microbial industry, most functional lipases are derived from fungi and bacteria. Fungi are more preferred because fungal enzymes are usually secreted in an extracellular manner, which facilitates the extraction of enzymes from the fermentation environment. In modern processes, fungal genes are expressed in bacterial systems (Jaeger and Eggert, 2002).

Applied plans for food technology

Most of the enzymes used in the industry are mainly applied to modify, alter and break down biomaterials. Most industrial lipases are used to develop flavor and aroma in dairy products and other foods, including meat, vegetables, fruits, cooked foods, and milk and beer production. Industrial applications of phospholipases have been identified in egg yolk treatments for the production of mayonnaise and other emulsions, lecithin modifications and refining of vegetable oil. The introduction of microbial phospholipases specifically enhances the enzyme production economy of refined vegetable oils. The function of phospholipids in egg yolk treatment is the hydrolysis of lecithin. Isolecithin increases the emulsion capacity and thermal stability. Therefore, egg yolks produced can be useful in sweets or porridges, mayonnaise, baby foods and white dough preparations (Sharma *et al.*, 2001).

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Dairy industry

Lipases are widely used in dairy industry for the hydrolysis of lipid milk. Using lipases, the length of the fatty acid chain can also be changed to increase the flavor and aroma of cheese. Common uses include cheese ripening speed and lipolysis of butter, fat and cream. Due to the effects of lipase on milk fat and a number of dairy products, especially soft cheeses with a desirable flavor and aroma, free fatty acid is produced. Common sources of lipase that are used to increase the taste and aroma of cheese are prepared from animal tissues, especially the pancreatic glands (cattle and pigs) and pre-gastric juices derived from young ruminants (kidneys, lambs and calves) (Rodrigues and Fernandez-Lafuente, 2010). In some cases, microbial lipases are successfully replaced for pre-gastric lipases. Good quality cheeses are produced using specific microbial lipases or several preparation mixtures. When cheese is incubated in the presence of enzymes at high temperature, the enzyme-modified cheese (EMC) is produced. In other words, an intermediary enabler is produced by the lipase catalytic reaction, which is used as a compound or the ingredient in other products such as sauce, soups and snacks. The fat content of cheese modified by EMC is about 10 times higher than that of ordinary cheeses (Kilcawley *et al.*, 2006)

Fat and oil industries

The correction of fats and oils is one of the primary areas in the food processing industry that creates a new economy and green technology. Lipases change the lipid characteristics by changing the location of fatty acid chains in the glyceride and replacing one or more fatty acids. In this manner, relatively inexpensive and less favorable lipids can be converted into valuable fats. The lipolytic transformations of fats and oils, esterification and interesterification are utilized to obtain value added products such as certain fats and glycerides, which are of higher potential for hydrolysis than fatty acid production. Derivation of phospholipids from vegetable oils has been recently developed in environmental processes by using highly selective microbial phospholipases (Sun *et al.*, 2012).

The use of granulation to stabilize lipase may be cost effective to produce quality foods. Lipase stabilization is also widely employed for interesterification of fats and oils suitable for frying foods. Although some of the lipases have been reported to be beneficial for stabilization, the lipase extracted from fungi such as *Rhizopus japonicus*, which is thermally known as a heat-resistant extracellular lipase producing agent, is very useful in utilization of catalyzed lipases transesterification. Lipase from *Rhizopus japonicus* is a relatively inexpensive, 50 degree heat resistant, acid pH–resistant enzyme. The enzyme is fixed on a celite base to overcome the mass transfer limitations. Due to its porosity and low cost, a celite is considered to be suitable for solvent application, and is preferred to porous bases such as glass. A favorable transesterification activity may be observed due to the stabilization of lipase on celite in a hexane environment, which is reasonably used for the enrichment of docosahexaenoic acid (DHA) in soybean oil. Due to the selectivity of *Rhizopus japonicus* lipase, on regions 1 and 3 of the glyceride (the “region is meant to be the location of fatty acid on the glycerol molecule), it has been widely used in the food and pharmaceutical industries (Khare and Nakajima, 2000).

Lipases as biosensors for the food industry

The stabilized lipase is fast, accurate and efficient. The application of lipases as a biosensor in the food industry, especially in fats and oils, soft drinks, non-alcoholic beverages, the pharmaceutical industry, as well as in clinical diagnosis, is of particular importance. The basic concept of using lipases as biosensor is to produce **glycerol from triacylglycerol** in analytical samples and determine the quantity of glycerol released by chemical or enzymatic reactions. Lipases can be fixed on the pH/oxygen electrode in combination with

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glucose oxidase, which is a lipid biosensor and may be used to detect blood triglycerides and cholesterol (Hasan *et al.*, 2006).

Flour and bakery industry

The baking industry is increasingly focused on lipolytic enzymes. Recent findings suggest that phospholipases can be used to replace or as supplements to traditional emulsions because enzymes reduce the polar lipids of wheat to produce emulsions *in situ*. Mostly, in order to make the flavor more desirable in the bakery products, lipases release short chain fatty acids via esterification. It not only improves the flavor, but also lengthens the shelf life of bakery products. An artificial lipase expressed in Aspergillus *oryzae* is used to aid the processing in the baking and bakery industry. All hydrolytic enzymes, including lipases, are used in reducing the effective primary strength and increasing the specific volume of the breads.

The recombinant yeast with Geotricum *Lip* 2 expresses a protein that has the same properties. In fermentation, the dough prepared with this type of recombinant yeast produces a higher volume and more uniform bread. The yeast with the gene *Lip*A of bacterial lipase leads to higher productivity than enzyme and is considered as an additive in baking bread(Sánchez *et al.*, 2002).

Other Food Processing Industries

In recent years, lipases have been used to produce a variety of products, from juices to fermented vegetables. Lipases facilitate the removal of fat from meat and fish. Sausage processing with microbial lipase is a new technology.. To inhibit the formation of bubbles in chocolate products, a series of fats are designed by enzymatic esterification reactions. The lipase of *Candida. rugosa* is widely used in food and aromatic processing of products such as ice cream, single-cellular proteins, carbohydrate esters and amino acid derivatives not obtainable by conventional chemical synthesis methods (Hasan *et al.*, 2006, Houde *et al.*, 2004, Kamini *et al.*, 2000).

The extraordinary potential of lipases in food applications indicates the need to develop technology to save time and cost and increase production. A large number of hydrolytic enzymes have applications such as the improvement of flavor and aroma in dairy products (cheese, butter and margarine), alcoholic beverages, milk, chocolate, etc. Food production and diet control, meat and sausage processing have high potentials in certain sources of the food industry. Lipase applications are rapidly expanding. New applications are still being studied in the food industry. Lipase characteristics are being improved by protein and genetic engineering to enhance its applications. In addition, there is a significant commercial potential of using these enzymes in industrial biotechnology.

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