

Enzymes in the dairy industry

[Business](#), [Industries](#)



Cherno Okafor Aida Stefani SBI4U October 20th, 2012 Assignment 1: Cellular Biology furtherstechnology-Enzymes in the Dairy Industry Since ancient times, enzymes have played an important role in food production. Especially in the dairy industry, some enzymes are required for the production of cheese, yogurt, and other dairy products, while others are used in a more specialized fashion such as improving texture or flavour of the product. Enzymes are used to catalyze the desirable reactions in industrial processes. Today, enzyme applications in such processing get more difficulties because of the rare occurrence and high costs.

The aim of using the microbial enzymes is to achieve this problem. Five of the more common types of microbial enzymes involved in the dairy industry involve: Rennet, Proteases, Lactase, Catalase, and Lipases. Milk contains proteins, especially caseins which maintain its liquid form. Proteases are enzymes that are added to milk during the process of cheese production, to hydrolyze caseins, like kappa caseins, which stabilizes micelle formation and thus preventing milk coagulation. On the other hand, rennet and rennin are general terms for enzymes used to coagulate milk.

The Chymosin enzyme which can be obtained from animal, microbial, or vegetable sources, is responsible for up to 70% of cheese production. It is now possible to produce chymosin in genetically modified fungi. These modified microorganisms contain the gene derived from the stomach of calves that is responsible for producing chymosin. When grown in a bioreactor, they release chymosin into the medium. Afterwards, the enzyme is extracted and purified, yielding a product that is 80%-90% pure. Natural rennin contains only 4%-8% active enzyme.

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Chymosin produced by genetically engineered microorganisms is now used to produce cheese in many different countries. Rennet (Chymosin) has owed to an increase in demand for cheese production worldwide. Rennin acts on milk in two stages, by enzymatic and by nonenzymatic action, resulting in the coagulation of milk. In the enzymatic phase, the resultant milk becomes a gel due to the influence of calcium ions and the temperature used in the process. Many microorganisms are known to produce rennet-like proteinases, as mentioned above, which can substitute the calf rennet.

Good yields of milk-clotting protease may be obtained in a medium containing 4% potato starch, 3% soybean meal, and 10% barley. During growth, lipase is secreted together with the protease. Therefore, the lipase activity has to be destroyed by reducing the pH, before the preparation can be used as cheese rennet. Protease is another notable enzyme. Cow milk contains a number of different whey proteins such as lactoglobulin and lactalbumin. The denaturing of these whey proteins, using proteases as catalysts, results in a creamier yogurt product. The denaturing of whey proteins is also essential for cheese production.

In addition, proteases reduce allergic properties of cow milk products for infants, which produce healthier milk for them. Lactase is a glycoside hydrolase enzyme that decomposes lactose into its constituent sugars of galactose and glucose. Lactose intolerant individuals can result from insufficient production of lactase enzyme in the small intestine. Feeding lactose-containing milk to lactose-intolerant individuals can result in discomforts such as: cramps, gas, dehydration, diarrhoea in the digestive tract upon ingestion of milk products, or maybe even death.

Lactase provides relief for lactose and tolerant individuals because it can be used commercially to prepare lactose-free products, particularly milk by the process of hydrolysis of the lactase into glucose and galactose. In addition, lactase enzymes can be used in preparation of ice cream to make a creamier, sweeter-tasting product and improving digestibility. Finally, this reduces sandiness due to crystallization of lactose in concentrated preparations. Also, cheese manufactured from hydrolyzed milk ripens more quickly than the cheese manufactured from normal milk.

Another problem presented by lactose is its low solubility. This prevents the use of concentrated whey syrups in many food processes as they have an unpleasant sandy texture and are readily prone to microbiological spoilage. Adding to this problem, the disposal of such waste whey is expensive due to its high biological oxygen demand. These problems may be overcome by hydrolysis of the lactose in whey; the product being about four times as sweet, much more soluble and capable of forming concentrated, microbiologically secure, syrups.

Technologically, lactose crystallizes easily which sets limits to certain processes in the dairy industry, and the use of lactase to overcome this problem has not reached its fullest potential because of the associated high costs. Moreover, the main problem associated with discharging large quantities of cheese whey is that it pollutes the environment. But, the discharged whey could be exploited as an alternate cheap source of lactose for the production of lactic acid by fermentation. In the production of cheese, hydrogen peroxide is a potent oxidizer and toxic to cells.

Catalase enzymes are used instead of pasteurization, when making certain cheeses such as Swiss, in order to preserve natural milk enzymes that are beneficial to the end product and flavour development of the cheese. Due to pasteurization, these enzymes would be destroyed by the high heat. Therefore, Catalase enzymes are typically added to convert the hydrogen peroxide to water and molecular oxygen which will enhance final production. Finally, there are the lipases in the dairy industry. Lipase enzymes are primarily used to break down milk fats and give characteristic flavours to cheeses.

The flavours come from the three fatty acids produced when milk fats are hydrolyzed. Hydrolysis of shorter chains of fatty acids is preferable as it results in desirable tastes of many cheeses unlike the hydrolysis of longer chains of fatty acids which could result in soapiness or no flavour at all. It is notable to mention egg products. Many industrially produced cream products used dried egg powder instead of fresh eggs. The enzymes of lipase and glucose are implemented in order to preserve egg powder and maintain its colour.

These enzymes are often produced with the assistance of genetically modified microorganisms. Genetically modified microorganisms result in better yields in simple systems. Several cheese making experiments have been carried out with recombinant chymosin and the general aspects of recombinant chymosin have been dealt with. Since most of the rennet (> 90%) added to cheese milk is lost in the whey, immobilization would considerably extend its catalytic life. Several rennets have been immobilized, but their deficiency as milk coagulants has been questioned.

So, there is a fairly general support for the view that immobilized enzymes cannot coagulate milk properly, owing to inaccessibility of the peptide bond of K-Casein, and that the apparent coagulating activity of immobilized rennets is due to leaching of the enzyme from the support. Different types of conventional cheeses have been successfully made by using recombinant rennet on an experimental scale. No major differences have been detected between cheeses made with recombinant chymosins or natural enzymes, regarding cheese yield, texture, smell, taste, and ripening.

Cheese ripening is a complex process mediated by biochemical and biophysical changes during which a bland curd is developed into a mature cheese with characteristic flavour, texture, and aroma. The desirable attributes are produced by the partial and gradual breakdown of carbohydrates, lipids, and proteins during ripening, mediated by several agents (i) residual coagulants, (ii) starter bacteria and their enzymes, (iii) nonstarter bacteria and their enzymes, (iv) indigenous milk enzymes, especially proteinases, and (v) secondary inocula with their enzymes.

Proteolysis occurs in all the cheese varieties and is a prerequisite for characteristic flavour development that can be regulated by proper use of the above agents. Cheese ripening is essentially an enzymatic process which can be accelerated by augmenting activity of the key enzymes. This has the advantage of initiating more specific action for flavour development compared to use of elevated temperatures that can result in accelerating undesirable nonspecific reactions, and consequently off flavour development.

Enzymes may be added to develop specific flavours in cheeses, for example lipase addition for the development of Parmesan or Blue-type cheese flavours. The pathways leading to the formation of flavour compounds are largely unknown, and therefore the use of exogenous enzymes to accelerate ripening is mostly an empirical process. Moreover, there are Proteolytic enzymes of lactic acid and bacteria in fermented milk products.

This system is composed of proteinases which initially cleaves the milk protein to peptides; peptidases which cleave the peptides to small peptides and amino acids; and transport system responsible for cellular uptake of small peptides and amino acids. Lactic acid bacteria have a complex proteolytic system capable of converting milk casein to the free amino acids and peptides necessary for their growth. These proteinases include extracellular proteinases, endopeptidases, aminopeptidases, tripeptidases, and proline-specific peptidases, which are all serine proteases.

Aminopeptidases are important for the development of flavour in fermented milk products, since they are capable of releasing single amino acid residues from oligopeptides formed by extracellular proteinase activity. Nevertheless, the other minor enzymes having limited applications in dairy processing include: glucose oxidase, catalase, superoxide dismutase, sulphhydryl oxidase, lactoperoxidase, and lysozymes. Glucose oxidase and catalase are often used together in selected foods for preservation. Superoxide dismutase is an antioxidant for foods and generates H_2O_2 , but is more effective when catalase is present.

Thermally induced generation of volatile sulphhydryl groups is thought to be responsible for the cooked off-flavour in ultra high temperature processed

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milk. Use of sulphhydryl oxidase under aseptic conditions can eliminate this defect. The natural inhibitory mechanism in raw milk is due to the presence of low levels of lactoperoxidase, which can be activated by the external addition of traces of H₂O₂ and thiocyanate. The societal impacts of some dairy enzymes are that chymosin, a high quality enzyme, is available at an attractive price.

This helps assure available of extra cheeses at a reasonable cost. Due to the lipases, there is a wide variety of flavourful, high-quality cheeses. To sum up, I think that it is amazing that there is a wide variety of alternatives of dairy products as a result of these enzymes that aid the dairy processes. The lactase enzymes can now help individuals enjoy the nutritional benefits and sensory pleasure of dairy products without gastrointestinal side effects by selecting lactose-free or lactose-low dairy products or by providing commercially available lactase to dairy products in the home.

It is interesting how these enzymes sustain processes that enable higher yields, more enzyme production; and higher activity, more efficient, affective, dynamic enzymes. Bibliography Category. " Enzymes in the Dairy Industry - Uses for Enzymes in Food Preparation - Enzymes and Dairy Products. " About. com Biotech and Biomedical Pages. About. com, n. d. Web. 20 Oct. 2012.

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