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Essex Road, Church Stretton, Shropshire, SY6 6AXPhone: +44 01694 725240tim.keates@agilent.com www.agilent.com this does just what I need, thanks so much, really nice and clearEmpty reply does not make any sense for the end user Enzymes are proteins produced by all living organisms. They are biological catalysts which conduct all biochemical reactions. This is a natural part of physiological processes essential for growth and allow life. When your body wants to transform food such as starch in bread or pasta into energy enzymes are used to convert the starch to simple sugars which can be used by your cells. Enzymes are efficient, and specific performing typically only one defined reaction over and over again. The fact that they come from nature means that they act at specific pH and temperature conditions/ranges, which make them sustainable and biodegradable alternatives to chemical processing in the food industry. Industrial enzymes can be extracted from plants or produced by microbial fermentation and purified. Enzymes have been used in food production for thousands of years. Our early ancestors discovered that cows stomach could turn milk into cheese. Today, we use enzymes in food to manufacture of everything from bread, wine, beer, juice and dairy processing and much more besides. In the bakery industry, different type of enzymes can be used as a natural way to keep bread softer for longer, enhance dough tolerance during processing or allow for reduction the egg content. Enzymes also enable manufacturers to use local grains like cassava to make beer and make dairy products suitable for those with lactose intolerance. Enzymes provide to bakery manufacturers sustainability benefits in terms of food waste but also cost savings In the bakery industry, different type of enzymes are a natural way to optimize raw material performance despite varying/seasonal quality, enhancing manufacturing efficiencies, softness, moistness, antistaling or desirably sensory properties of baked goods over extended shelf life, reducing additives and energy usage, food loss and food waste, with sustainability benefits. A recent environmental footprint estimated calculation found that (www.epa.gov) just 1 loaf of bread releases 1.15kg of CO_2 emissions and uses 194L of water, which is equivalent to the same CO_2 emissions from fully charging 140 smart phones and 2 average daily showers. Delving deeper into food waste, according to United nations environment programme up to 10% of GHG are linked to uneaten food, and 30% of all food produced in wasted, costing the global economy over $900 billion per year. More especially the various type of bakery enzymes are offering different functionalities. Maltogenic amylase allows to keep bread softer for longer, to extend shelf life, by improving product sensory characteristics and appearance over longer shelf life, prolonging the onset of staling characteristics and reducing likelihood of food being wasted at home. Xylanases are known to improve dough tolerance during processing. Asparaginase, to make baked good healthier by reducing the acrylamide content. Some phospholipases allow to successfully reduces egg content by up in fine bakery applications such as muffins, stirred cakes, whipped cakes, croissants, donuts and brioche, with no change in dough handling or crumb structure versus a full egg recipe, eggs being crucial to bakers because of their specific functional properties and unique contribution to finished product sensory attributes: texture, softness, crumb structure, taste, including "binding", "aeration", "emulsification" and "colour". Lactose, the sugar found in dairy products, can cause problems like bloating and other gastrointestinal discomforts in people with lactose intolerance. Lactose intolerance affects a significant amount of people worldwide, especially in places where dairy farming is not common. The incidence of lactose intolerance can be as high as 75% of the population in these areas. Enzymes can help lactose intolerant individuals enjoy dairy products with minimal side effects. Lactose is a sugar made of two smaller sugars: galactose and glucose. Lactase is an enzyme that cleaves lactose into these two smaller sugars, neither of which cause the negative side effects of lactose in those with lactose intolerance. This is why you see the ingredient 'lactase' in lactose-free milks, for example. Get KHNI articles delivered to your inbox Did you know that using lactase can also help with reducing added sugar, though? The breakdown of the lactose sugar molecule gives glucose and galactose. These sugars have a greater relative sweetness than lactose meaning that lactose free or low-lactose products that have been made with the lactase enzyme are sweeter in taste than those not treated with lactase. In the food industry this can allow dairy products like yoghurt to be made with a reduced amount of added sugar but with the same taste profile. It is recommended by the world health organisation that infants be exclusively breastfed for the first 6 months of life so as to give the infant the greatest chance of achieving optimal growth, development and health, but for cases where this is not realistic or possible, infant formula is required. Some infants have a hard time digesting certain types of formula, but enzymes can help in a few ways. Comfort Protein – Infant Milk Formula (IMF) Comfort infant formulas are made with partially hydrolysed milk proteins which are marketed as "easier to digest" infant formula made from cows milk. These formulas can be produced using natural enzymes, called proteases, which target proteins and are derived from animal, plant or microbial sources. Hydrolysis of milk proteins by proteases results in the formation of smaller peptides which are reported to be more readily digested than intact proteins. In particular, parents of infants suffering from conditions such as colic, cite the use of comfort protein as reducing the severity of symptoms. Hypoallergenic Formulas (IMF) Most common IMFs use cow's milk as a base, but a small percentage of infants are born with cow's milk protein allergy (CMPA). Formulas sold to address this condition can be divided into two types – those which are extensively hydrolysed (peptide-based) and those which are amino acid based. Extensively hydrolysed proteins for this application are produced via enzymatic hydrolysis where the protease enzyme extensively breaks down the structure of the whey and/or casein protein to smaller peptides. From the American Academy of Family Physicians: "Hypoallergenic formulas contain extensively hydrolyzed proteins that are less likely to stimulate antibody production. Infants with milk protein allergy fed hypoallergenic formula have slightly greater weight gain during the first year than infants fed standard formula. In addition, many infants show improvement in atopic symptoms. A few infants continue to have symptoms despite switching to hypoallergenic formula; nonallergenic amino acid–based formulas are effective for these rare cases" The market for nutritional beverage is growing and cereal based beverages such as Horlicks, Bournvita, etc. have traditionally been very popular in certain markets. The plant-based beverage market has continued to grow with milk-alternatives like soy or oat milk. Enzymes are often used to help make these beverages more acceptable to consumers. For example, plant-based beverages like oat or rice milk can have poor emulsion stability, meaning products might separate out over their shelf life instead of remaining a consistent mixture. Enzymes like amylase can help improve stability of the product. Much like lactase, amylase can also reduce the need for added sugar because the products of starch hydrolysis are sweeter than the starch itself. If high viscosity is caused by high molecular weight (Mw) beta-glucan, as in the case of a beverage like oat milk, beta-glucanase can be used to make an easier to process, less viscous product. However, since beta-glucan is the fiber associated with health benefits in oats, cleaving beta glucan with an enzyme would likely reduce the potential health benefit. If health benefits and fiber content are a focus, beta glucanase may not be the best solution. With the rise in demand for plant-based proteins, there has been an increased demand for inexpensive plant-derived protein hydrolysates, owing to their significant potential in nutritional applications. Hydrolysed plant protein (HPP) is most commonly produced via the enzymatic hydrolysis of a plant protein source such as soy, wheat, rice, sunflower, potato and alternative pulse proteins, and are used in a wide variety of food applications such as protein fortified bars and beverages. Protease enzymes are most commonly used in the production of HPPs and under controlled conditions are used maximise protein yields from different plant sources and also to improve taste and sensory attributes. From a commercial standpoint, plant proteins maintain unique taste attributes, and today's HPP products are synonymous with bitter, unpleasant tastes often attributed to a high concentration of hydrophobic free amino-acids, smaller peptides and volatile compounds in the HPP mixture. Enzymatic hydrolysis, both pre- and post-hydrolysis can help to significantly improve these undesirable sensory properties of HPPs. This article was originally published on 15 September 2020. It was updated 19 June 2023 to reflect new information. Niall Higgins, Ph.D joined Kerry in 2016 in a role responsible for the development of Kerry enzyme technologies, driving the full innovation chain from concept design to product delivery. Since then Niall has held multiple positions within Kerry as R&D Manager, Integration Lead, Senior Business Development Manager and now Head of Product Innovation, based at c-LEcta, Leipzig, Germany. Full BIO & Contributor Articles Dr. Billy Ryan joined Kerry's team in 2014 and has since held roles in RD&A, technical sales support and business development within Kerry's Enzymes business. Dr Ryan is responsible for Kerry's Business Development activities for enzymes globally. Dr. Ryan completed his PhD and BSc degrees in University College Cork, Ireland where he specialised in Microbiology. Full BIO & Contributor Articles Dr. Josh Taylor joined Kerry in 2016 as part of the enzymes research and development team developing new enzyme systems to improve yields and quality for customers in food and beverage products all over the world. Prior to joining Kerry, Josh completed a BSc (Hons) in biotechnology in National University of Ireland Galway. Full BIO & Contributor Articles Dr. Jacques Georis is part the senior leadership team in charge of business strategy and ensuring its execution for Functional Ingredients Pillar (where BU Enzymes sits), being accountable for RD&A and R&SA functions. Additionally Jacques leads the R&D strategy for Global Fermentation R&D and the co-owner of Process Technology Fermentation Excellence Program within Kerry. Full BIO & Contributor Articles References Martínez MB et al., (2003) Anales de Pediatría (58) 100-105 Paige, D. M. (2013). Lactose intolerance. Encyclopaedia of human nutrition (3rd ed.), pp. 67–73 Sicherer SH (2011) Journal of Allergy and Clinical Immunology (127) 594-602 von Berg A et al., (2003) Journal of Allergy and Clinical Immunology, (111) 533-540 To help you plan your year 8 science lesson on: Digestion and enzymes, download all teaching resources for free and adapt to suit your pupils' needs.The starter quiz will activate and check your pupils' prior knowledge, with versions available both with and without answers in PDF format.We use learning cycles to break down learning into key concepts or ideas linked to the learning outcome. Each learning cycle features explanations with checks for understanding and practice tasks with feedback. All of this is found in our slide decks, ready for you to download and edit. The practice tasks are also available as printable worksheets and some lessons have additional materials with extra material you might need for teaching the lesson.The assessment exit quiz will test your pupils' understanding of the key learning points.Our video is a tool for planning, showing how other teachers might teach the lesson, offering helpful tips, modelled explanations and inspiration for your own delivery in the classroom. Plus, you can set it as homework or revision for pupils and keep their learning on track by sharing an online pupil version of this lesson.Explore more key stage 3 science lessons from the Human digestive system unit, dive into the full secondary science curriculum, or learn more about lesson planning. Great resource, good picture and questions. Had to play with the formatting to print everything without losing the edges but still saved me ages Empty reply does not make any sense for the end user NewNewShareSwitch to our new teaching resources now - designed by teachers and leading subject experts, and tested in classrooms.These resources were created for remote use during the pandemic and are not designed for classroom teaching.View new resourcesI can describe parts of the digestive system and how they are adapted to digest food.1 Slide deck1 Worksheet2 Quizzes1 VideoI can describe the processes of mechanical and chemical digestion that break down food to release nutrients, including the role of enzymes.1 Slide deck1 Worksheet2 Quizzes1 VideoI can carry out tests for nutrients and some of the substances they are broken down into.1 Slide deck1 Worksheet2 Quizzes1 VideoI can describe the important roles of bacteria in the human digestive system.1 Slide deck1 Worksheet2 Quizzes1 VideoI can describe how the digestive system and circulatory system work together to absorb nutrients and transport them around the body.1 Slide deck1 Worksheet2 Quizzes1 Video Overview: enzymes are protein molecules that act as catalysts, speeding up chemical reactions without themselves getting used up. Each enzyme will only speed up a specific reaction, for example, catalase will speed up the decomposition of hydrogen peroxide into water and oxygen but it will not speed up the breakdown of starch into glucose. Enzymes (e.g. catalase) have active sites with specific shapes that bind to the substrate molecule (e.g. hydrogen peroxide) forming an enzyme-substrate complex. The enzyme-substrate complex then breaks down into the enzyme and product, allowing the enzyme to go on and react with another substrate molecule. Temperature and pH affect enzyme function because they can change the shape of the enzyme's active site, preventing it from binding to the substrate, just as a broken lock will no longer fit the key. When the shape of an enzyme changes we call this denaturation. Any factor that increases the frequency of collisions between enzymes and substrates (increasing concentration, surface area or temperature) will increase the rate of reaction. Big idea: organisms are organised on a cellular basis and have a finite life span Key concept: enzymes are protein molecules with specific shapes that speed up chemical reactions without being used up. Factors such as concentration, temperature and pH affect enzyme action. Prior knowledge: rates of reaction; bonding; catalysts and activation energy Misconception [scientific idea]: enzymes die when they are heated [enzymes cannot be killed as they are not living, instead enzymes denature when they are heated above a certain temperature]; enzymes denature when it's cold [frequency of collisions decreases between substrate and enzyme]; enzymes only break down large molecules [enzymes can also speed up reactions involving building large molecules from smaller ones e.g. protein synthesis] The decomposition of hydrogen peroxide is a great place to begin thinking about enzymes. The decomposition of hydrogen peroxide into water and oxygen will happen spontaneously, but the addition of a catalyst e.g. catalase will speed this reaction up. Don't believe me?! Then have a go at the decomposition of hydrogen peroxide demonstration using MnO_2 (a chemical catalyst) and a piece of liver (containing catalase, a biological catalyst). Heat the liver and it no longer works. This will then begin an exploration of denaturation. Modelling enzyme action One of the best ways to help students understand enzyme action is to build Plasticine models of enzymes breaking down (or building up) substrate molecules. Students can modify the models to show denaturation and the effects of temperature, inhibitors and pH. Make sure you stress the different effects of temperature – denaturation versus collision theory. If possible, ask students to film their models and add annotations to help them consider the dynamic nature of enzyme action. What do enzymes look like? The Protein Data Bank provides some beautiful structures of enzymes. Factors that affect enzyme action GCSE activity for students to apply their knowledge of enzymes. Students work in pairs to apply their understanding of factors that affect enzymes. They will need to consider pH, temperature and enzyme specificity. This activity assesses and consolidates learning by asking students to apply their knowledge to novel situations. (PDF) Thinking deeper What does lemon juice, snake venom and cyanide have in common? Why can you make pineapple jelly from tinned pineapple but not fresh pineapple? When we cool an enzyme reaction the rate of reaction decreases. Do enzymes denature at low temperatures? How does decreasing the pH cause denaturation? Why do you die of heat stroke? Biological molecules Food tests Enzymes Photosynthesis Respiration ↵ Back to Biology teaching resources Established in 2015 and born out of our commitment to sharing the science of healthier food with the food industry, the KHNI brings together a network of over 1100 Kerry scientists, Scientific Advisory Council and external partners, passionate about bringing the voice of science to some of the most challenging questions facing the food and beverage industry. Ever wondered what your liver was for? Worth looking after it!Enzymes! There are tens of thousands of chemical reactions going on inside our bodies all the time.I'm at a farmers' market in Edinburgh to show people how enzymes contained in an animal liver can help turn a dangerous chemical like hydrogen peroxide into something totally safe.Welcome to the wonderful world of enzymes!Do you know what your liver's good for?Not really.What your liver's good for... is for breaking down stuff. I'm going to show you how that works. OK. First I'm going to take some of this stuff. Put on my safety goggles... Hydrogen peroxide - you can use it to bleach your hair if you like to look pretty! When you eat stuff your body breaks it down but it can produce some harmful chemicals and this is one of them. Because it's the detox organ in the body the liver is full of enzymes that work as catalysts to speed up the breakdown of harmful chemicals. Catalysts speed up chemical reactions without being used up or chemically changed. Enzymes speed up reactions - they make things happen quicker. In our bodies hydrogen peroxide is broken down by the enzyme called catalase.Sorry I don't do liver - I just I don't like it.What happens when the catalase in liver comes into contact with hydrogen peroxide?I've added some blue washing-up liquid which shows you the gases more clearly. Liver is effective at breaking down the hydrogen peroxide. And it does this by breaking it down into water and oxygen.' That is what we call an enzyme reaction and it's caused by catalase in our liver.Thank you!Hydrogen peroxide has the molecular structure H202. Catalase splits it up into H20 and 02 - water and oxygen - but how does it work? Every enzyme has a place in which the molecule fits exactly. This is known as the active site. The active site of the catalase allows the hydrogen peroxide molecule to fit exactly. You could say the active site is like the ring of a bottle opener. The hydrogen peroxide molecule slots exactly into the active site and it's that that splits up the molecule into oxygen and water - breaking up the dangerous hydrogen peroxide and making it safe. Good stuff that liver!