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A Novel Way of Designing Healthier Food and Drink Products

New opportunities for enzymes

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A Leatherhead Food Research white paper

A Novel Way of Designing Healthier Food and Drink Products

Consumer demand for food and drink products with health benefits is greater than ever before and this is driving an ongoing need for innovative solutions to create healthier formulations. In this white paper, Sophie Pealing outlines the potential to develop food and drink products with added health benefits by using crosslinking enzymes to alter the structure of food matrices.

By 2025, 2.7 billion people will be classified overweight or obese, according to the World Obesity Federation. This is an increase from two billion in 2014. Obesity (and the corresponding diseases associated with it, such as diabetes and coronary heart disease) is a major, global, public health concern[1].

Consumers have become more aware of their diet and the nutritional profiles of food and drink products. Half of consumers globally are currently trying to lose weight[2]. Leatherhead's own research with UK consumers shows over eight in ten are conscious of the sugar in their diet. Importantly for manufacturers, an overwhelming majority of consumers, across all age groups, are willing to pay more for healthier foods[2].

This is driving significant innovation in the development of food and drink products with added health benefits. There is particular interest in health benefits that are linked to weight and nutrition management, such as satiety-inducing food and drink products that can help keep individuals fuller for longer and low glycaemic index (GI) foods which can play a role in managing blood glucose levels.

Enhancing product functionality with enzymes

Exploitation of enzymes that can create healthier products is now gaining attention in product innovation circles. These enzymes can either hydrolyse or induce molecules to crosslink together, creating new macromolecular structures and giving the foodstuff new textural properties.

An emerging class of enzymes, crosslinking enzymes, such as transglutaminases, tyrosinases, peroxidases and laccases, can be used to modify food proteins and carbohydrates. These work by inducing formation of covalent bonds between and/or within proteins in the food matrix. This creates new macromolecular assemblies with enhanced physicochemical properties and

[1] Miao, M *et al.* (2013). Dual-enzymatic modification of maize starch for increasing slow digestion property. Food Hydrocolloids 38 180-185.
[2] Nielsen's Global Health and Wellness Survey

functionalities[3]. Once modified, the rheological properties of the food and drink products are altered[4,5].

Increasing satiating properties in products

While crosslinking enzymes have been used by the industry to alter the texture of foods, for example in the production of surimi (paste made from fish or meat), ham and sausages, the opportunities for crosslinking enzymes to improve the health benefits of products is now the focus for innovation.

It is widely understood that protein is more satiating than other macronutrients followed by carbohydrates and then fat[6]. Crosslinking enzymes can change the protein network to increase the satiating effect of a product, improving its functional characteristics, without affecting its nutritional qualities[7,8].

We know from studies where the structure of casein (a milk, protein-based model) has been altered by using transglutaminase, this has had an impact on the appetite of healthy males[9]. Results showed feelings of fullness were greater after consumption of the casein crosslinked by transglutaminase compared with the consumption of regular casein and whey proteins.

The enzymatic modification through the use of crosslinking enzymes leads to firmer food matrices that are harder and slower to digest, yet crucially do not change the nutritional properties of the product. This offers huge potential to innovation teams creating food and drink products with satiety benefits.

A role in low GI foods

The development of low GI foods is another example of a health-specific use of enzymes. It is well-known that low GI foods are beneficial in the prevention and treatment of a number of chronic diseases. These foods work to slow down the rate of carbohydrate digestion, which helps to maintain blood glucose levels and provide extended energy absorption[10].

Different starches have different rates and extents of digestion in the body. Based on these differences, starch can be classified as:

- Rapidly digestible starch (RDS) - whereby ingestion leads to a rapid increase in blood glucose levels and subsequent insulin response
- Slowly digestible starch (SDS) - whereby starch is digested at a much slower rate resulting in moderate glycaemic and insulin response[1]

Using SDS to improve the blood glucose response of foods is of increasing interest to food manufacturers and health professionals alike. Here enzymes may have a role. For

[3] Wong SS, Jameson DM (2012) Chemistry of protein and nucleic acid cross-linking and conjugation, 2nd edn. Taylor&Francis, Boca Raton
[4] Rastall, R. (2007) Novel Enzymes Technology for Food Applications. Woodhead Publishing Limited. Cambridge.
[5] Buchert, J., et al. (2010) Crosslinking food proteins for improved functionality Ann. Rev. Food Sci. Technol. 1 pp. 113-138.
[6] Latner, J.D. & Schwartz, M., (1999) The effects of a high carbohydrate, high protein or balanced lunch upon later food intake and hunger ratings *Appetite* 33, 119-128.
[7] Gerrad, J. A. (2002) Protein-protein crosslinking in food: methods, consequences, applications. *Trends Food Sci Technol* 13, 391-399.
[8] Feeney, R.E. & Whitaker, J.R., (1988) Importance of cross-linking reactions in proteins. *Adv Cereal Sci Technol* 9, 21-46.
[9] Juvonen, K.R et al. (2011). Structure modification of a milk protein-based model food affects postprandial intestinal peptide release and fullness in healthy young men. Br J Nutr. 2011; 106(12): 1890-8.
[10] Miao, M et al. (2011). Structural characterizations of waxy maize starch residue following in vitro pancreatin and amyloglucosidase synergistic hydrolysis. Food Hydrocolloids, 25, 214-220.

example, maize starch can be modified using β-amylase and transglucosidase. This dual enzyme treatment has been shown to decrease the molecular weight and increase the amount of short chains and α-1,6 linkages, both of which produce new branched structures with slowly digestible character. This treatment will therefore decrease the GI of the starch[1].

The future for enzymes is 'clean'

As consumer demand for food and drink products with health benefits grows, so too do the opportunities for enzymes. While more research is needed, enzymes show enormous potential as a novel way of altering the structure of food matrices and ultimately introducing health benefits to food and drink formulations.

Not only do enzymes offer tremendous opportunities to innovation teams creating products with health benefits, but because enzymes are usually deactivated and may result in non-catalytic proteins, the enzymes may not remain in the final product. If the enzyme does not need to be included on ingredient labels, this enables manufacturers to achieve the clean label they desire.

How Leatherhead can help

Leatherhead has expertise in food rheology (texture and mouthfeel), microscopy (visualisation of microstructure which influence the textural properties) and food processing. We can advise and support manufacturers in the use of crosslinking enzymes to develop products with health and nutritional benefits.

About the author

Sophie is a Technical Advisor in the Food Innovation department at Leatherhead Food Research. She obtained her BSc (Hons) in Nutrition and Food Science from the University of Nottingham. At Leatherhead, Sophie is responsible for confidential client projects and managing the technical enquiry service. Sophie covers a wide range of areas, including: technical, processing, manufacturing, ingredients (including food additives), product development, reformulation, food safety and HACCP.

About Leatherhead Food Research

Leatherhead Food Research provides expertise and support to the global food and drink sector with practical solutions that cover all stages of a product's life cycle from consumer insight, ingredient innovation and sensory testing to food safety consultancy and global regulatory advice. Leatherhead operates a membership programme which represents a who's who of the global food and drinks industry. Supporting all members and clients, large or small, Leatherhead provides consultancy and advice, as well as training, market news, published reports and bespoke projects. Alongside the Member support and project work, our world-renowned experts deliver cutting-edge research in areas that drive long term commercial benefit for the food and drink industry.

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