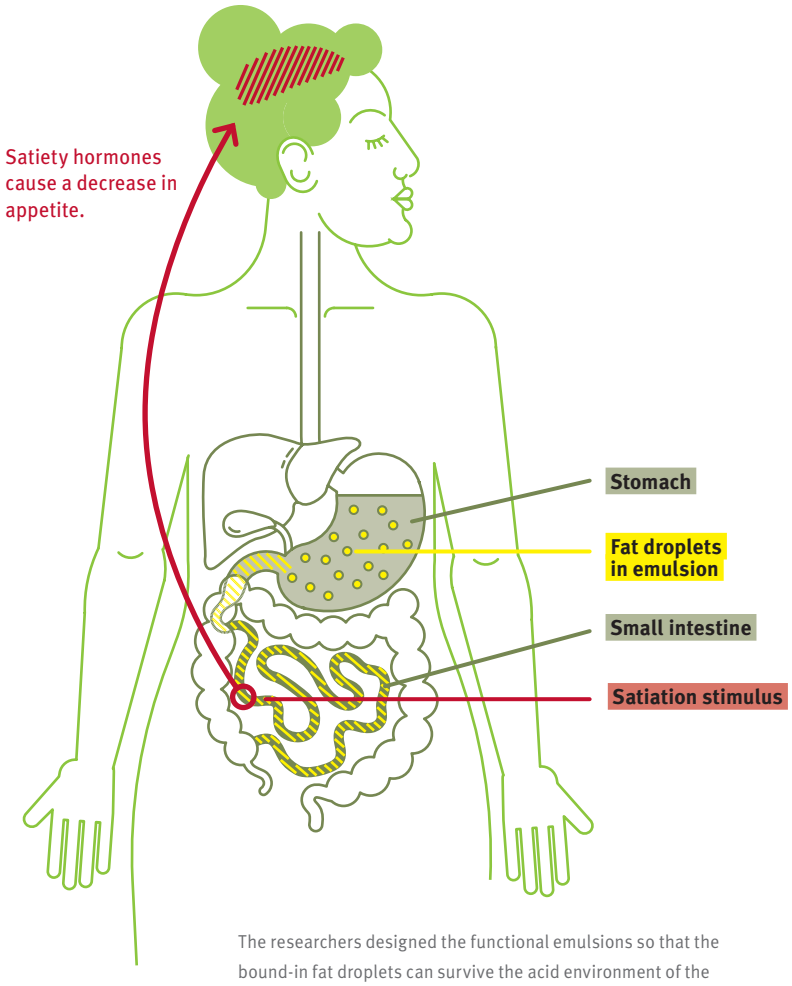
National Research Programme NRP 69
Healthy Nutrition and
Sustainable Food Prodution

In vivo validation of functional food emulsion systems

Prof. Peter Fischer
Institute of Food, Nutrition and Health, ETH Zurich

Using functional food emulsions to control energy intake more effectively

An NRP 69 research group has developed various functional emulsions capable of prolonging satiation – the feeling of fullness – following a meal. In the course of various trials, the researchers have proven that this type of food specifically affects digestion and eating habits and can thus help people to eat more healthily. One primary present-day application of these emulsions is the treatment of morbid obesity in the clinical setting. Furthermore, the results of the project are helping to improve our understanding of how fat is digested in the gastrointestinal tract and the natural endogenous mechanisms that regulate satiation.



The researchers designed the functional emulsions so that the bound-in fat droplets can survive the acid environment of the stomach. When a large amount of fat droplets passes at once from the stomach to the small intestine, the satiation stimulus is triggered. The satiety hormones released in the bloodstream cause a decrease in appetite.

Diet has already been linked to diabetes, cardiovascular disease and certain types of cancer, and is thought to be a contributory factor in a constantly growing number of disorders. As a result, unhealthy eating impairs quality of life and is a factor in the growing cost of healthcare. Innovative approaches are needed to develop new solutions to morbid obesity, chronic dietary deficiencies and malnutrition. Functional food – i.e. foodstuffs that are fortified with additional nutrients to make them healthier – are one such highly promising area. As part of NRP 69, a group of researchers at ETH Zurich, the University of Zurich and Zurich University Hospital developed and tested functional emulsions that prolong satiation following a meal. The emulsions help to delay the return of appetite after a meal and consequently reduce further energy intake. This effect could help to encourage healthier eating habits – something that would benefit morbidly obese people in particular.

The project enabled the researchers to gain a better understanding of food intake, and especially the hormonal mechanisms that regulate satiation in the human body. The research work was driven by the hypothesis that people feel full when a large amount of fat passes from the stomach to the small intestine. As digestion of the fat begins in the intestine, satiety hormones are released in the bloodstream. The researchers wanted to make use of this natural regulating mechanism by developing functional foods capable of specifically triggering the satiation stimulus in the small intestine using bound-in fat droplets.

Resistance to stomach acid

One of the key challenges encountered in the project was the acid environment of the stomach, where food is pre-digested after ingestion. The acid in the stomach, in combination with certain enzymes, breaks down a lot of fat, thus delaying its transit into the small intestine. Consequently, the satiation stimulus is not triggered as reliably as one would like. Functional foods therefore have to be designed so that they can transport the fat droplets through the stomach in as intact a condition as possible. The project developed three different functional food emulsions, each of which contained the same fat droplets. However, the surrounding structures protecting the droplets against disintegration in the stomach were designed with different stabilities.

The researchers then investigated the properties of the three emulsions in different tests. In a first trial, the emulsions were tested on animals. This test showed that the more stable emulsions with a greater resistance to stomach acid resulted in higher concentrations of satiety hormones in the blood. In consequence, animals' energy intake was lower. A second test was conducted in vitro. In an environment similar to the human stomach, the scientists analysed how the structure of the emulsions changed under certain chemical conditions. In a third test, they trialled the three emulsions in healthy adults. Sixty minutes after eating the functional food, the participants had a magnetic resonance imaging (MRI) scan of their stomachs, which showed the structure and distribution of the fat from the emulsion. In addition, the blood of the participants was analysed for various biomarkers, providing information on how effective the emulsions were in triggering the satiation stimulus.

The results from the project show that the functional emulsions that were tested are capable of triggering the satiation stimulus in both animals and humans. They are suitable for specifically affecting digestion and thus control energy intake more effectively.

Further information:
www.nrp69.ch

Application

Initial applications for emulsions in the clinical setting

The project showed that the functional food emulsions developed by the researchers can prolong satiation after eating. This type of functional food could therefore potentially be used in the treatment of morbid obesity. The emulsion system could help patients to better control their energy intake and to eat more healthily. For the time being, the clinical setting is the most appropriate field of application, for example in managed treatment to reduce body weight. At present there are no plans to make the functional emulsions available to a broader target group because their taste is not palatable for consumers. However, it may be possible to continue developing the technology so that it can be incorporated into salad dressings or drinks.