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## Foods and satiety

- New EU-legislation allows the use of scientifically substantiated weight regulation and satiety-related health claims on foods
- Network of Nordic scientists and food industry working with satiety and weight regulation related issues
- Literature review of current knowledge on food properties affecting satiety and/or weight management



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<b>Abstract:</b> The new EU-legislation allows the use of weight regulation and satiety-related health claims on foods, if sufficient scientific evidence exists behind the claims. This offers new opportunities to food industry. Within this joint Nordic collaboration project "Substantiation of weight regulation and satiety related health claims on foods" (Weighty), a network of Nordic scientists and food industry working with satiety and weight regulation related issues has been created. In a literature review written by the scientists the current knowledge on food properties affecting satiety and/or weight management has been examined, as well as the potential biomarkers that have been proposed to have a role in satiety and/or weight management. In addition, the group has participated in the discussion on the topic with other actors in the Europe. The results of the project have been disseminated in the form of articles and presentations to food industry, scientists and other stakeholders.		
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# Executive summary

## The objective of the project was:

- To create a network of Nordic scientists and food industry who work with satiety and weight regulation related issues
- To assist Nordic food industry to exploit the opportunities that new EU-legislation will allow in weight regulation and satiety-related health claims

## Implementation

- The available data on food properties and potential biomarkers that have been suggested to affect satiety and/or energy expenditure has been collected and evaluated
- A literature review on this data has been written and is published as part of this report
- Suggestions on satiety and weight management-related health claims for dietary fibre and protein have been sent to food authorities
- We have participated in the European discussion about practices in using weight regulation and satiety-related health claims by organizing a joint workshop with ILSI (International Life Sciences Institute) with an invited speaker from EFSA (European Food Safety Authority)
- Results of the project have been disseminated to food industry, scientists and other stakeholders in the form of articles and presentations

## Main conclusions:

- Based on the literature review, dietary fibre and protein are the most potential nutrients linked with satiety and weight management.
- The effect varies depending on the type and source of protein and fibre, which makes it challenging to establish a general dietary fibre or protein claim.
- Dose-response relationships are not always easy to define.
- The scientific evidence behind two step claims may allow easier substantiation of the claim compared to product-specific claims; e.g. “High in fibre. Fibre may increase satiety” compared to “This product increases satiety”.
- Further studies are needed for confirming the long-term effects of foods high in satiating capacity on the long-term regulation of food intake and body weight.

## Recommendations for continued studies:

- Dose-response relationship would be important to define in order to help in the development of highly satiating foods
- Satiety-related research would benefit from a ‘golden standard’ regarding the methodology and it would help to evaluate the research results
- The link between satiety and long-term weight management should be verified

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## Introduction

The new EU regulation on nutrition and health claims made on foods came into force in January 2007 and has been implemented since July 2007 (Regulation (EC) No 1924/2006). The regulation applies to all nutrition and health claims and covers all foods, including foods provided in restaurants, schools, food supplements and foodstuffs for particular nutritional use. It covers health and nutrition claims in labels, advertisements and promotional campaigns. Although food industry may benefit from the use of the claims by promoting their products, the intended purpose of health claims is to benefit and protect consumers by providing scientifically sound information on healthful eating patterns and relationship between food and health. Thus, all health claims used in the labelling, advertising or promotion of food or food supplements must be substantiated.

The weight regulation and satiety-related health claims on foods belong under article 13.1. claims. They may refer to “slimming or weight-control or a reduction in the sense of hunger or an increase in the sense of satiety or to the reduction of the available energy from the diet”, but can not refer to the rate or amount of weight loss (Regulation (EC) No 1924/2006). The article 13 claims should be based on generally accepted scientific evidence and be well understood by the average consumer. The scientific evidence behind the article 13 claims is evaluated by EFSA (European Food Safety Authority). The Commission will establish the list of accepted claims by January 31, 2010.

Research on different nutrients, texture and form of foods and their relationship with satiety and weight management is very active at the moment. The search for food products with enhanced effect on satiety-related perceptions, achieved by e.g. an added ingredient or certain texture, and the relationship between the use of these products and weight management is a hot topic, not least because of the expanding obesity epidemic.

The objective of this project was to create a network of Nordic scientists and food industry who work with satiety and weight regulation-related issues and in this way assist Nordic food industry to exploit the opportunities that new EU-legislation will allow. This objective was mainly addressed by

- Writing a literature review on the current knowledge on food properties that have been proposed to affect satiety and/or energy expenditure, thus possibly contributing to weight management

- Participating in the discussion with other actors in the Europe

## **Summary of the literature review on satiety, weight management and foods**

A literature review written in this project pulls together the latest knowledge on food properties that have been proposed to affect satiety and/or energy expenditure, and might therefore be useful in weight control. In addition, the potential biomarkers of satiety are also explored, as well as methods for measuring satiety. The whole literature review will be published as part of this report. In the following the main content of the literature review is presented in a nutshell and conclusions made.

### ***Foods for increased satiety and weight management***

Food has a central role in weight management. Research on different nutrients, texture and form of foods and their relationship with satiety and weight management is very active at the moment.

Traditionally, foods linked with slimming and weight management have been so called ‘light-products’ with reduced energy content. It is possible to decrease the energy content of the diet by including them into the diet, if the rest of the diet remains unchanged. An alternative option is to develop food products with enhanced effects on satiety-related perceptions by modifying the composition and/or texture and/or form of the product. Including these products in the diet could favourably affect the amount of the rest of the food eaten and thus the energy content of the diet.

### **Food intake regulation - some concepts**

Many different factors, biological, behavioural and environmental, have an influence on appetite. *Hunger* is the biological drive that forces us to search for food. It determines when we eat, what we eat and how much we eat (Blundell et al. 1996). Eating stimulates the physiological processes that inhibit further eating and reduces hunger. *Satiation* (intrameal satiety) is the term used for feeling full and stopping to eat (see Gerstein et al. 2004). On the other hand, *satiety* (intermeal satiety) develops after the eating occasion and determines the meal intervals (see Gerstein et al. 2004). It also may affect the food consumption at the next meal (see Gerstein et al. 2004).

In everyday language and life hunger is usually understood as an opposite for satiety. However, hunger-related sensations are not simply the absence of satiety-related sensations. For example, after a large meal satiation is increased, but simultaneously hunger can be elevated when a palatable dessert is offered after the meal.

## **Measuring satiety**

There is no single, standard method to measure satiety. The challenge in measuring satiety is the great amount of variation on how satiety is perceived because of different individual eating styles and habits and also because of the subjective nature of the term. One commonly used method is to rate the subjective satiety-related sensations before and after eating a test product or a test meal (e. g. Holt and Brand-Miller 1994, Porrini et al. 1995, Turconi et al. 1995, Holt et al. 2001, Rolls et al. 1998, Flint et al. 2000). Another also commonly used method is to measure the energy intake or amount of food eaten after the test product or test meal (e g. Holt and Brand-Miller 1995, Porrini et al. 1995, Holt et al. 1995, 2001, Guinard and Brun 1998, Zandstra et al. 1999, Flint et al. 2000). Of course also both of the methods can be used simultaneously and the combination gives a better estimate of the satiating effect of the test food. The assumption is that a food that increases short-term satiety decreases the amount of energy ingested subsequently and thus could potentially help in weight management in the long run.

A visual analogue scale (VAS) is the most commonly used method to measure subjective ratings of satiety. The end points of the scale are verbally anchored, e.g. “I’m extremely hungry/I’m not at all hungry”. The participants mark the scale corresponding to their subjective feeling at the particular time point. In a typical study design the participants rate their sensations during 2-3 hours after the ingestion of a meal or test product at certain intervals, e.g. every 15-30 min. Of course also longer follow-up periods can be used. For analysing the results, a graphical curve can be drawn from the assessments done at different time points and the area under the curve be calculated (Flint et al. 2000).

## **Biomarkers of appetite**

The search for the physiological biomarkers of appetite is currently very active. Many gastrointestinal hormones released during or after eating are involved in the regulation of food

intake. It is possible to measure the concentrations of many satiety-related peptides in blood and thus observe the changes that occur in the peptide concentrations after the ingestion of a test meal or a particular food.

The composition of the test food determines which peptides and at what concentrations are released. Recently compounds ghrelin, peptide YY (PYY) and GLP-1 (glucagon-like peptide 1) have achieved perhaps most attention. GLP-1 and PYY are involved in satiety between meals (Cummings & Overduin, 2007). They both slow down the gastric emptying time and prolong the small intestine transit time. The effect of ghrelin is the opposite and the concentration of ghrelin typically increases before eating and decreases soon after eating (Cummings & Overduin, 2007). Thus, ghrelin increases appetite and affects the initiation of eating. The signals from the gastrointestinal tract are mediated to the brain where, finally, the regulation of food intake occurs. Nevertheless, no single biomarker for this complex regulation pathway has been detected yet.

### ***What kind of foods for weight management?***

Research on the effects of different macronutrients on satiety and weight control is active, but the results are not conclusive yet. According to the current knowledge, dietary fibre and protein are among the most potential nutrients affecting satiety and weight control.

#### **Dietary fibre**

Many studies point to the direction that dietary fibre may be associated with satiation, satiety and reduction of energy intake (see Slavin and Green 2007). However, there are significant differences between different types of fibres in their ability to affect satiety and energy intake. The link between soluble, high-viscous fibres (such as oat  $\beta$ -glucan) and non-soluble fibres (such as wheat bran and rye fibre) and satiety and weight management is convincing (Slavin and Green 2007), whereas the scientific evidence behind the satiating effects of soluble, non-viscous fibres (such as polydextrose) is limited at the moment (Slavin and Green 2007). The effect of fibre may also depend on the physical form of the food where it is present or added, in other words, whether the food is e.g. solid or liquid.

## **Dietary protein**

High protein food has shown to produce most enhanced satiety (Johnstone et al. 2008, Veldhorst et al. 2008, Westerterp-Plantega & Lejeune 2005; Halton & Hu 2004) and to promote weight management (Clifton et al. 2008; Westerterp-Plantega & Lejeune, 2005; Halton & Hu, 2004). However, not all kind of proteins produce the same effect (Veldhorst et al. 2008), but likely the differences are smaller compared to the differences between fibres.

## ***Future suggestions***

Despite the convincing evidence behind dietary fibre and protein regarding their satiating/weight regulation effects, there is not yet conclusive knowledge on how much fibre or protein is needed in a portion of a certain food product in order to achieve the targeted satiating effect. In other words, the definition of dose-response relationship would help in developing products with enhanced satiety. One option would be to apply two-step claims that would first inform about the content of e.g. fibre or protein in a product (“This food is rich in dietary fibre/protein”) and then make a link to the health effect (Dietary fibre/protein can decrease hunger”. Also, more research is needed on clarifying the differences between different types of fibres and proteins and especially on their long-term effects on weight management.

## **Discussion with other actors**

The Weighty group and ILSI Appetite Regulation Task Force and Expert Groups (ILSI = International Life Sciences Institute) and an EFSA representative met in May 2008 with the objective to share knowledge and discuss about the research on food components, mechanisms and biomarkers related to appetite and methodologies to measure appetite and satiety-related perceptions. The following issues were emphasised in the discussions held in the meeting:

- What would be a meaningful change in relevant variables as demonstrated by statistical significance?
- Dose response, the whole effective dose must be included in the portion size
- Generic vs. specific product based claims; what would a generic claim for satiety look like?
- The importance of characterization of the functional ingredient

- A way to identify the robust studies by using certain agreed criteria
- Product specification is important for evaluating the claim within the context of the food matrix
- It may be too difficult to include everything into one claim type. Instead, the claims could have different range of 'strength'. For example, a weaker claim could state that the product X reduces hunger. A stronger claim could state that the product reduces food intake over a certain period. The strongest claim would state that the product reduces energy intake. Even a 'weaker' claim could benefit the consumers.

The challenge with the different study designs is that there is no 'gold standard' for appetite and satiety research with regard to methodology. Another important question is, whether the satiety-related claims can be linked with longer term weight management. At the moment few studies support this link. It was concluded that more studies are needed before this assumption can be made. About the wording of the claims: It was emphasised that it is important to carefully select the reference product to the product for which the claim is applied for. It is possible only claim things that have been tested. In other words, if it is stated a product 'A' increases satiety more than product 'B', then the test results should also directly support this claim and the comparison of the products should be made in such way that an unambiguous result is obtained.

## **Conclusions and recommendations**

The new EU-legislation on nutrition and health claims has been implemented since July 2007. It allows the use of weight regulation and satiety-related health claims, if they are based on generally accepted scientific evidence. However, to date, there is not yet consensus on how weight regulation and satiety-related claims are substantiated and what kind of evidence is sufficient.

In this project "Substantiation of weight regulation and satiety related health claims on foods", funded by the Nordic Innovation Centre, the current knowledge on food properties that have been proposed to affect appetite and/or energy expenditure has been reviewed. Based on this, at the moment the scientific evidence regarding dietary fibre and protein and their short-term satiating effects is the most convincing. The challenges still are that the dose-response relationship is often difficult to define and may vary depending on the food matrix used, as well as the type of dietary

fibre or protein used. Thus, it seems more realistic that the so called two-step claims indicating a certain product as a “good source of fibre” and demonstrating the effect “fibre can decrease hunger” could be applied. Further studies are needed for verifying the link between satiety and long-term weight management.

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