Nutrition, Metabolism & Cardiovascular Diseases (2011) 21, 748–756

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/nmcd

Nutrition, Metabolism & Cardiovascular Diseases

Semisolid meal enriched in oat bran decreases plasma glucose and insulin levels, but does not change gastrointestinal peptide responses or short-term appetite in healthy subjects

K.R. Juvonen [a,*], M. Salmenkallio-Marttila [b], M. Lyly [b], K.-H. Liukkonen [b], L. Lähteenmäki [b], D.E. Laaksonen [c,d], M.I. Uusitupa [a], K.H. Herzig [e,f], K.S. Poutanen [a,b], L.J. Karhunen [a]

[a] *Food and Health Research Centre, Department of Clinical Nutrition, Institute of Public Health and Clinical Nutrition, University of Eastern Finland, P.O.Box 1627, FI-70211 Kuopio, Finland*
[b] *VTT Technical Research Centre of Finland, Espoo 02044, Finland*
[c] *Department of Medicine, Kuopio University Hospital, Kuopio 70211, Finland*
[d] *Institute of Biomedicine, Physiology, University of Eastern Finland, Kuopio 70211, Finland*
[e] *Institute of Biomedicine, Division of Physiology and Biocenter of Oulu, Oulu University, Oulu 90014, Finland*
[f] *Department of Psychiatry, Kuopio University Hospital, Kuopio 70211, Finland*

Received 25 August 2009; received in revised form 13 January 2010; accepted 1 February 2010

KEYWORDS
Oat bran;
Wheat bran;
Viscosity;
Postprandial;
Appetite;
Gastrointestinal peptides

Abstract *Background and aims:* Dietary fibre (DF) may play an important role in weight control. The amount, type and way of processing of DF modify food structure and subsequent postprandial appetitive, metabolic and hormonal effects, but current understanding about the magnitude of effects that specific types and amounts of DF exert are still poorly understood. *Methods and results:* We investigated the effects of wheat and oat brans alone and as combination in semisolid food matrix on postprandial appetite profile and gastrointestinal (GI) hormonal responses. Twenty healthy, normal-weight subjects (5 male/15 female, aged 23.3 ± 0.85y) participated in the study. Isoenergetic and isovolumic (1250 kJ, 300 g) puddings with different insoluble and soluble DF content were tested in a randomised order: pudding with 1) no added fibre, 2) 10 g wheat bran DF, 3) 10 g oat bran DF and 4) combination including 5 g wheat bran DF + 5 g oat bran DF. Blood samples were drawn before and 15, 30, 45, 60, 90, 120 and 180 min after the test meals to determine plasma glucose, ghrelin, peptide YY (PYY) and serum insulin concentrations. Subjective profiles of appetite were assessed using

Abbreviations: AUC, Area under the curve; DF, Dietary fibre; GE, Gastric emptying; GI, Gastrointestinal; PYY, Peptide YY; VAS, Visual analogue scale.

* Corresponding author. Tel.: +358 40 355 2245; fax: +358 17 162 792.
E-mail address: kristiina.juvonen@uef.fi (K.R. Juvonen).

0939-4753/$ - see front matter
doi:10.1016/j.numecd.2010.02.002

visual analogue scales (VAS). Plasma glucose ($P = 0.001$) and serum insulin ($P < 0.001$) responses were the lowest after the pudding with the greatest amount of β-glucan. In contrast, postprandial ghrelin or PYY responses or appetite sensations did not differ among the meals.
Conclusion: Oat β-glucan decreased postprandial plasma glucose and serum insulin responses, yet had no significant effects on GI peptide responses or appetite ratings.

Introduction

A convincing body of evidence supports a favourable role of dietary fibre (DF) as a part of a healthy diet. Most significantly, cereal fibre consumption has been shown to be associated with a lower risk for type 2 diabetes and cardiovascular disease [1,2]. These findings have emphasised the importance of DF, which are also reflected in the dietary guidelines of many Western and non-Western countries to increase consumption of foods rich in unrefined grain products and DF [3].

The type of DF plays a role in modulating the metabolic effects observed after fibre-rich meals. Soluble fibres with viscous characteristics modify properties of chyme already in the upper part of the gastrointestinal (GI) tract affecting gastric emptying (GE), gut motility and nutrient absorption, which are reflected in lower postprandial glycaemic and insulinaemic responses [4,5]. Evidence from various studies supports that DF intake has favourable effects on appetite sensations, satiety, fullness and suppression of hunger [6,7]. These beneficial effects have been associated both with soluble [8,9] and insoluble fibres [10,11], whose characteristics affect the entire GI tract. In addition to the positive mechanical and physical effects on GI tract, DF may also influence the secretion of appetite-related GI peptides, e.g. ghrelin and peptide YY (PYY) which contribute to the meal-related orexigenic and anorexigenic signalling. These peptides are secreted in different proportions along the GI tract - ghrelin released mainly in the stomach and PYY in the lower part of the intestine [12]. Although the secretion of these peptides has been shown to be modulated by different macronutrients [13], their regulation by different fibre types is still largely unknown. This is important because DF is very heterogeneous with respect to their physical and chemical properties, e.g. solubility, viscosity, fermentability and molecular weight.

The impact of DF on appetite-related peptides and appetite may have important implications especially with respect to weight loss and weight maintenance [14–16]. Therefore the objective of our study was to examine the effects of common cereal fibres differing in physical properties, e.g. in water solubility, on postprandial glucose, insulin and gastrointestinal peptide responses and sensations of appetite.

Methods

The Research Ethics Committee of Hospital District of Northern Savo approved the study protocol performed in accordance to the principles of the Declaration of Helsinki. Prior participation each individual gave a verbal and written informed consent. The screening procedure of the subjects, study design and biochemical measurements have been described in detail previously [8].

Subjects

Twenty healthy normal-weight volunteers (Table 1) were recruited in the study at the Department of Clinical Nutrition, University of Kuopio via an intranet announcement at the university campus. In total 31 potential subjects were screened and all twenty eligible participants finished the study.

Test products

Four isoenergetic and isovolumic puddings (Tables 2 and 3) were served as test meals. The bases of the puddings were prepared on the previous day by mixing semolina, black currant juice concentrate and tap water. The bases were then cooked in the microwave oven and stored in the refrigerator overnight. On the subsequent morning, the rest of the ingredients were added to the bases, which were then whipped for 2 min to form a fluffy texture. Wheat and/or oat brans were added in the bases just before serving the meals. An *ad libitum* buffet-like meal, which consisted of vegetable soup, oat and rye breads, margarine, soft cheese, sliced cucumber, non-caloric orange juice and tap water, was served 3 h after the test meal consumption.

Study design

The study had a single-blind, randomised, crossover design. All participants tested each pudding with a minimum of 2 d separating the individual test days. A 12 h fast preceded all the study visits. During the study visits, subjects ingested with 400 mL of water one of the following meals within 10 min in a randomised fashion: a pudding with (1) no added cereal fibre, (2) 10 g fibre from wheat bran, (3) 10 g fibre from oat bran, (4) combination of 5 g wheat bran + 5 g oat bran fibre (Table 2).

Pre- and postprandial blood samples were drawn to determine the concentrations of serum insulin and plasma glucose, ghrelin and PYY through an antecubital cannula before and 15, 30, 45, 60, 90, 120 and 180 min after the test meals. Subjective appetite was assessed at the same time points immediately after blood sampling. Pleasantness and