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Research report

The satiating effects of eggs or cottage cheese are similar in healthy subjects despite differences in postprandial kinetics ☆

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ABSTRACT

Studies have reported a better satiating effect of eggs when compared with common cereal-based breakfasts, an effect that can be attributed to their macronutrient composition. Our aim was to compare the satiating power of an omelette and cottage cheese, both being common food snacks with similar nutrient compositions (containing proteins and lipids) but in different food forms. Thirty healthy volunteers participated in a randomized crossover trial. On each test day, the subjects consumed one of the two snacks, both providing 1346 kJ, 26 g protein, 21 g lipids, and 8 g lactose. The elapsed time between the snack and lunch request, their food intake at lunch, and their satiety scores were recorded. In a subgroup of 10 volunteers, blood was sampled to measure plasma metabolites and hormones. The two preloads were similar in terms of the time between the snack and a request for the buffet (167 ± 8 min), energy intake at the buffet (3988 ± 180 kJ) and appetite ratings. Plasma amino acid and urea concentrations indicated a marked delay in kinetic delivery after the eggs compared with the cottage cheese. In contrast, glucose, triglycerides and cholesterol displayed similar profiles after the snack. GIP and insulin secretions increased significantly after the cottage cheese, while glucagon and GLP-1 secretions were delayed with the omelette. We conclude that despite important differences in protein kinetics and their subsequent effects on hormone secretion, eggs and cottage cheese had a similar satiating power. This strongly suggests that with dose of proteins that is compatible to supplement strategies, i.e. 20–30 g, a modulation of protein kinetics is ineffective in increasing satiety.

Introduction

Some studies have shown that eggs eaten at breakfast were more satiating than croissants or cereals in normal weight subjects (Fallaize, Wilson, Gray, Morgan, & Griffin, 2013), and also more satiating than bagels in overweight (Ratliff et al., 2010) and obese subjects (Vander Wal, Marth, Khosla, Jen, & Dhurandhar, 2005). In these studies, the satiating effect of eggs was marked not only by decreased feelings of hunger, but also a lower energy intake. Their macronutrient composition may have been responsible for this effect, as the egg breakfast contained a higher protein content than the other breakfasts tested. Therefore, proteins were claimed to be more satiating than carbohydrates and lipids, although this theory continues to be challenged in the literature (Porrini et al., 1997; Potier

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et al., 2010; Raben, Agerholm-Larsen, Flint, Holst, & Astrup, 2003). Moreover, eggs contain fat and no carbohydrates; it has been shown that the absence of any carbohydrates and a high proportion of fat in a diet increases appetite suppression (Veldhorst, Westerterp, van Vught, & Westerterp-Plantenga, 2010).

In addition to nutritional composition, the rates of nutrient delivery and absorption have also been proposed as having a significant effect on satiety (Hall, Millward, Long, & Morgan, 2003; Juvonen et al., 2012; Steinert, Meyer-Gerspach, & Beglinger, 2012). This has frequently led to questions about the effects of the viscosity, texture, or form of foods. For instance, solid meals (including protein meals) were recognized as being more satiating than liquid meals, even though the energy intakes were similar (Leidy, Bales-Voelker, & Harris, 2011; Martens, Lemmens, Born, & Westerterp-Plantenga, 2011; Mattes & Campbell, 2009; Stull, Apolzan, Thalacker-Mercer, Iglay, & Campbell, 2008), but this was not necessarily the case with CHO snacks (Almiron-Roig, Flores, & Drewnowski, 2004; Martens, Lemmens, Born, & Westerterp-Plantenga, 2012). The use of gel-forming fibre in snacks has also been reported as being effective in increasing satiety over a day, although the effects were very modest (Wanders, Mars, Borgonjen-van den Berg, de Graaf, & Feskens, 2014).

In this context, the present study aimed to test the satiating effect of eggs, cooked as an omelette, compared with that of cottage cheese. The two products were formulated to have a similar composition but a different food form. We hypothesized that either the nature of proteins and lipids, or the delivery kinetics of the nutrients induced by the food form, might trigger different satiety responses. For this purpose, the satiating effects of an omelette and cottage cheese were assessed in normal-weight volunteers under a cross-over design. To challenge the theory of a link between satiety and digestion rate, metabolite and hormone profiles were also examined in a subgroup of the study subjects.

Materials and methods

Snack

The snacks were composed of either cottage cheese or eggs. They were formulated to have a similar macronutrient composition (Table 1), and they supplied 26 g protein (32% as energy), 21 g fat (59% as energy) and 8 g CHO (9% as energy), with a total energy content of 1342 kJ. Cottage cheese and raw egg snacks had a similar energy density of 5.22 kJ/g. The cottage cheese was flavoured with vanilla and sweetened with 1 g aspartame. The eggs were cooked as an omelette without adding any fat, and the same standardized procedure was applied throughout the study, i.e. using the same cooktop and pan, time and intensity of cooking.

Lunch

All the food items for the *ad libitum* lunch were widely available industrial products. Before starting the study, we verified that the volunteers liked the different foods proposed in order to reduce unfavourable reactions. The *ad libitum* lunch was comprised of pasta with tomato sauce, fresh cheese, fruit salad and water. All the food was served in generous portions to be sure that each volunteer reached satiety by the end of their meal.

Table 1
Snack composition.

	Cottage cheese	Eggs
Cottage cheese (g)	200	–
Skimmed milk (g)	7.5	–
Caseins (g)	10	–
Liquid whole egg (g)	–	210
Lactose (g)	–	8
Water (g)	40	40
CHO (g)	8	8
Lipids (g)	21	21
Proteins (g)	26	26
Energy (kJ)	1342	1342

Participants

All participants were certified as being in good health after a thorough physical examination performed by medical staff in the Human Nutrition Research Centre (HNRC) at Avicenne Hospital (Bobigny, France), and routine biochemical tests. The eligibility criteria were $18 < \text{BMI} < 25$ kg/m^2 and $18 < \text{age} < 40$ years. The exclusion criteria were: positive serological findings for HIV, AgHbS and HCV, any pathological condition, allergy to dairy or egg proteins, pregnancy or an absence of contraception in women. The purpose and potential risks of the study were fully explained to the subjects. All participants granted written, informed consent and the Ethics Committee for Saint-Germain-en-Laye Hospital approved the protocol. The study was registered under ClinicalTrials.gov (NCT01154582, OVONUTRIAL). It was performed in the HNRC at Avicenne Hospital according to a randomized, crossover design.

The sample size was determined using a power calculation, based on literature on the satiety assessment of caloric loads, with the satiety duration and the energy intake at lunch as outcomes. For the satiety duration, we targeted a difference of 20 min associated to an overall standard deviation of the duration of 50 min (Marmonier, Chapelot, Fantino, & Louis-Sylvestre, 2002); for energy intake, we targeted a difference of 150 kcal and an overall standard deviation of 350 kcal (Hall et al., 2003; Juvonen et al., 2012; Steinert et al., 2012). Thirty subjects, 16 females and 14 males, were recruited and accordingly participated in the study between March 2009 and June 2010. BMI was 22.7 ± 1.8 kg/m^2 and age 27 ± 6 years. A subgroup of 10 subjects (6 females and 4 males, BMI: 22.4 ± 1.5 kg/cm^2, 28.5 ± 6 years) was selected for collection of blood samples at the same time as the satiety assessment. This sample size was considered sufficient to detect postprandial kinetic differences in respect to previous studies (Bos et al., 2003; Hall et al., 2003; Lunde, Hjellset, Holmboe-Ottesen, & Hostmark, 2011; Marmonier et al., 2002).

Protocol

The subjects were assigned randomly to a sequence in order to ensure that 50% of the subjects would consume the egg snack on the first day.

For satiety measurements, the subjects underwent two satiety tests separated by a 2-day interval, as described previously (Marsset-Baglieri et al., 2014). The volunteers arrived at the HNRC in the morning, after fasting overnight. They were placed in a room which contained no time cues (closed curtains and no television, watch or personal computer). They were allowed to read and listen to pre-recorded music. At 8:00, they were given a standardized breakfast (1170 kJ) that included 120 mL skimmed milk, 30 g cornflakes, 100 mL orange juice, 20 g sugar and tea or coffee, which they had to ingest in totality. At 11:00, subjects ingested the snack, which was either cottage cheese or omelette. They drunk 150 mL of water and they had nothing else to drink until the lunch. After ingestion of the snack, they were asked to request lunch when they felt hungry. The elapsed time between the snack and the spontaneous meal request was recorded, as was the elapsed time between the snack and the spontaneous consumption at lunch. From when they had settled into the room until the end of the lunch, the volunteers completed visual analogue scales (VAS) every 15 minutes throughout the first half-hour and then every 30 minutes to assess their appetite feeling. The subjects were asked to indicate, on a scale from 0 to 100 mm, how they felt at the moment they read the following questions: How hungry do you feel now? How