



Short communication

Consuming pork proteins at breakfast reduces the feeling of hunger before lunch

Lene Meinert*, Ursula Kehlet, Margit Dall Aaslyng

Danish Meat Research Institute (DMRI), Maglegaardsvej 2, 4000 Roskilde, Denmark

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ABSTRACT

This study investigated the effect of pork proteins consumed at breakfast on the subsequent feeling of hunger until the evening meal. The study involved 136 students at a local boarding school, which meant that the study could be carried out in the test persons' normal environment. All students consumed the control breakfast on one of the two test days, and then half the students consumed the medium-protein breakfast and the other half the high-protein breakfast on the other test day, thereby acting as his/her own control. It was clearly shown that consuming a medium- or high-protein breakfast decreased the hunger ratings until lunch (4 h) compared with a control breakfast. A dose-response relationship related to the amount of proteins consumed at breakfast was observed, the high-protein breakfast leading to feelings of being less hungry compared with consuming a medium-protein breakfast. However, there was no direct link between hunger ratings and actual energy intake at lunch. The self-reported snacking during the whole day showed no clear relationship with the type of breakfast consumed.

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Introduction

It is well established that proteins induce a higher degree of satiety compared with both fat and carbohydrates (Barkeling, Rössner, & Bjorvell, 1990; Stubbs, van Wyk, Johnstone, & Harbron, 1996). Furthermore, it has been shown that food items rich in proteins induce greater specific satiety and reduce the feeling of hunger compared with similar foods with a lower content of proteins (Van Dewater & Vickers, 1996), which implies a dose-response effect. Globally, pork is an important meat source and thereby also an important source of protein in many people's diet. However, there is a general lack of knowledge concerning pork and satiety.

In many cultures, breakfast is based on carbohydrates, e.g. cereals. Proteins from meat are on the other hand typically eaten at lunch or at the evening meal. Having knowledge about the high degree of satiety from protein, it would be interesting to establish whether the proteins consumed at breakfast could have an effect on satiety throughout the entire day, or whether this effect decreases, e.g. after lunch. The influence of the time at which the proteins are eaten has not been thoroughly investigated.

The aim of this study was to investigate the effect of pork proteins served as brunch sausages at breakfast on satiety and food consumption until the evening meal at 5.30 pm among a large group of young people in familiar surroundings. Furthermore, the aim was to investigate if there was a dose-response effect (the number of sausages) on satiety.

Methods

Experimental design: This study was performed at Osted Boarding School. This is a traditional kind of Danish school that teaches ordinary senior grade students (9th and 10th grades). The boarding school was an ideal place to conduct the study, since the students consume all their meals at the school. School children (76 girls and 60 boys) aged between 15 and 17 all participated voluntarily.

A randomised within-subject design was used in the study, and therefore each participant acted as his/her own control. On two consecutive days, the participants were given a protein-rich breakfast or a control breakfast (control). The protein-rich breakfast was further divided into two groups, with one half of the students receiving a medium-protein breakfast and the other half receiving a high-protein breakfast. Prior to the study, the researchers were provided with a list of all the students whom were then randomly allocated by gender to receive either the high-protein or the medium-protein breakfast. Hunger was measured as the feeling of hunger on a 100 mm visual analogue scale (VAS) ranging from "0 = not at all hungry" to "10 = extremely hungry" (e.g. Silberbauer, Frey-Rindova, & Langhans, 1996). The students were requested to eat all the sausages. Otherwise, intake of the rest of the meal and served drinks (tea, coffee, water and milk) was optional under the assumption that the food and drink intake was habitual at breakfast. At lunch, the meal was served in a fixed portion size, but the students were free to ask for more, if they wanted, and it was voluntary to eat all the served lunch. The students were asked to rate their feelings of hunger five times: (1) before breakfast (7 am), (2) right after breakfast (7.30 am), (3) 1½ h after breakfast (9 am), (4) right before lunch (12 pm, approx. 4½ h after breakfast)

* Corresponding author.

E-mail address: lme@teknologisk.dk (L. Meinert).

and (5) right before the evening meal (5.30 pm, approx. 10 h after breakfast).

All participants noted if they had had extra servings at both breakfast and lunch. Any leftovers were weighed. Between the three main meals (breakfast, lunch and evening meal), the participants registered if they had had any snacks and, if so, what kind of snacks, e.g. candy, biscuits, fruit etc. As this was based on self-reporting and the students were not consistent in reporting the amounts, these results were transferred into (1) no snacking, (2) healthy snacking and (3) unhealthy snacking.

The breakfast meals were designed to have an average energy content of 3.0 MJ for boys and 2.9 MJ for girls to meet varying requirements of the subjects according to the Nordic Nutrition Recommendations. The energy intake at breakfast for each participant was calculated as follows: Energy intake = Energy in served breakfast + energy from extra intake – energy in leftovers. Table 1 shows the content of pork protein and the total energy from proteins in the different meals.

Statistics

All collected hunger data were analysed by a mixed model having student as random effect and type of meal (control, medium protein, high protein), gender and the interaction between these as fixed effect and the actual energy intake as a co-variant (proc mixed SAS, SAS Institute, Cary, USA). The energy intake was analysed by a general linear model having meal, gender and the interaction between these as fixed effects (proc mixed SAS, SAS Institute, Cary, USA). The snack intake was analysed using a χ^2 test.

Results

The self-reported hunger ratings were recorded during the day, Fig. 1.

It is clear from Fig. 1 that all students felt equally hungry before breakfast ($F(2, 121) = 0.08$, $p = 0.9186$). The students were not advised to fast from the day before, but, with school rules denying access to the kitchen during the evening and at bedtime at 10.30 pm the students most likely did not eat anything from 10 pm during the nights before the two study days.

Right after breakfast ($F(2, 121) = 2.53$, $p = 0.08$) and also after the first class at 9 am. ($F(2, 96) = 1.90$, $p = 0.156$), no significant difference was seen in hunger between the three meals. The high protein meal did therefore not alter the hunger during the first hour after the breakfast compared with the control. Right before lunch, the overall feeling of hunger was rated higher than before breakfast independently of the type of breakfast consumed. However, after consuming the high-protein breakfast the students felt significantly less hungry before lunch compared with those having consumed the control breakfast ($F(2, 107) = 3.17$, $p = 0.046$). Increasing

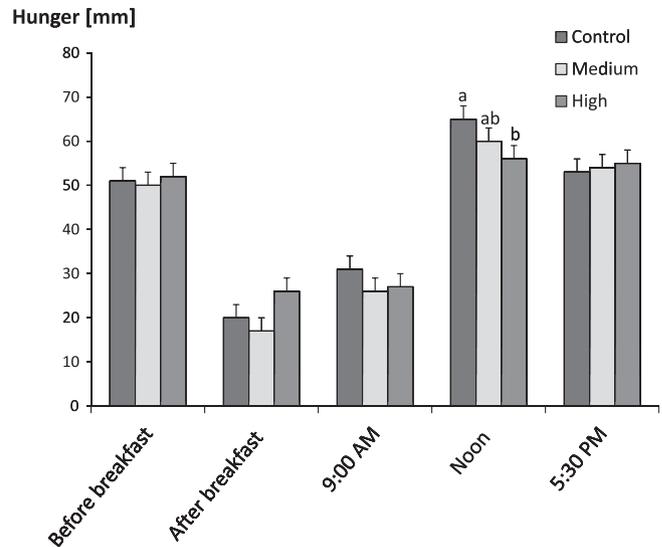


Fig. 1. Hunger ratings measured using an anchored 100 mm VAS of students at five times during the day: right before breakfast (7 am), right after breakfast (7.30 am), at 9 am, right before lunch (12 pm), and right before the evening meal (5.30 pm). The breakfast served was either (1) control breakfast, (2) medium-protein breakfast or (3) high-protein breakfast.

the number of sausages decreased the corresponding feeling of hunger, leading to a tendency towards a dose-response effect. Before the evening meal, the satiety effect from breakfast had clearly declined and did not affect the feeling of hunger ($F(2, 79) = 0.19$, $p = 0.8270$). Interestingly, the overall hunger ratings before the evening meal were lower compared with the overall ratings right before lunch. The actual energy intake at breakfast corresponded to an average of 3.00 MJ for boys and 2.85 MJ for girls. There were no significant differences in energy intake at lunch between the three breakfast meals.

The students were also instructed to note whether they had eaten any snacks between the meals, both the healthy snacks, e.g. fruit, and the unhealthy snacks, e.g. sweets. The purpose of snack-reporting was to see if the protein breakfast meals had an effect on snacking by reducing the snack intake or by getting the student to choose the more healthy snacks. The snack intake is shown in Fig. 2.

According to Fig. 2 the majority of the students did not consume any snacks before lunch. However, if snacking occurred, the students mostly consumed unhealthy snacks as sweets, cake and crisps. There were no significant differences in snack intake before lunch among the three breakfast groups.

In the afternoon, almost 60% of the students who consumed the high-protein breakfast meal did not snack compared with approx. 42% and 25% of the students who consumed the control and the medium-protein breakfasts, respectively.

Discussion

This study demonstrated that protein-rich breakfasts had an effect on subjective appetite 4 h after consumption. The main difference in composition of the three breakfast meals was the amount of pork sausages. The actual energy intake from the breakfasts appeared to be equal as leftovers was registered.

Pork was chosen as the main protein source as few studies had investigated the role of pork in relation to satiety. Also, pork sausages were considered suitable to be included in the breakfast test meals as pork sausages are an ordinary and accepted food item within the breakfast meal. The findings of the present study are

Table 1

Content of pork proteins in the breakfast meals assigned to the different groups and the percent of energy (of total energy) from proteins.

| Meals related to groups | Pork protein (% of total protein) | Protein (% of total energy) |
|-------------------------|-----------------------------------|-----------------------------|
| Boys – control | 0 | 10.7 |
| Boys – medium protein | 44.8 | 17.5 |
| Boys – high protein | 61.6 | 20.6 |
| Girls – control | 0 | 10.5 |
| Girls – medium protein | 35.1 | 16.1 |
| Girls – high protein | 56.1 | 17.5 |

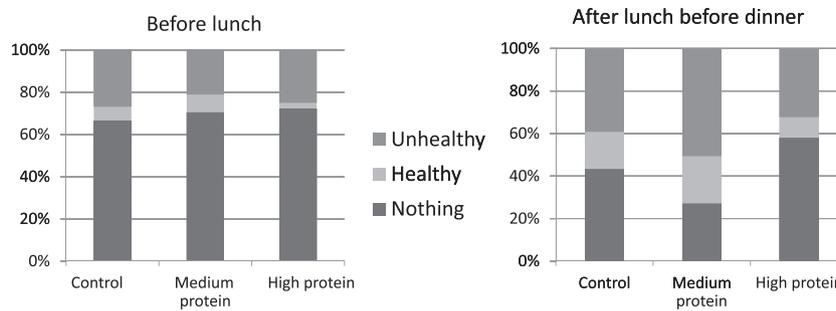


Fig. 2. The percentage of students consuming snacks (healthy snacks, e.g. fruit and unhealthy snacks, e.g. candy and cake) before lunch and in the afternoon related to the consumed breakfast: (1) control breakfast, (2) medium-protein breakfast or (3) high-protein breakfast.

therefore considered to be specific to the pork proteins as the majority of the proteins in the protein-rich breakfasts originate from pork, and it emphasizes therefore that previous results with other animal protein sources (e.g. Borzoei, Neovius, Barkeling, Teixeira-Pinto, & Rössner, 2006; Uhe, Collier, & ÓDea, 1992) are valid for pork proteins as well.

The fact that there was no difference in energy intake at lunch or in snacking is important to consider. If the reduction in hunger should contribute to maintenance of energy balance or weight loss, a spontaneous decrease in energy intake is necessary. Different factors may have influenced the energy intake at lunch. On both test days, the lunch was well liked/accepted by the students which could induce a high intake independent of hunger. The lunch was served in fixed portions and some students could have felt obliged to eat the whole serving, which is not an uncommon feeling, especially in social settings (Herman & Polivy, 2005; Kral, 2006).

The protein content of the two protein-rich breakfasts was in line with the Nordic Nutrition Recommendations for protein levels, which state that 10–20% of energy should be provided by protein per meal/day. This could be a too small protein level to induce a reduction in energy intake at lunch after the medium- and high-protein breakfast meals even though the level of hunger was influenced. In other comparable studies, in which an effect of proteins were observed, the protein levels vary from 25 E% (Larsen et al., 2010) to 29 E% (Mikkelsen, Toubro, & Astrup, 2000). This is considerably higher than those in the present study. This could explain why the present study did not find any reduction in energy intake during lunch after the medium- and high-protein breakfast meals.

This study is unique due to (1) the recording of satiety feelings and energy intake on an individual level among a large number of participants and (2) its controlled and systemized design still performed in every-day known and familiar surroundings. The study participants represented an average group of young Danish people in terms of their weights, based on visual observations during the study period since their actual weights and heights were not recorded.

Limitations of the present study include allocation of only half of the study participants to the high- and medium-protein breakfast, respectively. Ideally, the participants should be allocated to each of the two protein-rich breakfasts to observe a true dose-response relationship of protein intake and subjective appetite. However, in order to include all three breakfasts in a within-subject design, three test days would be necessary which was considered too strenuous for the study participants in this study. The number and nature of snacks could be prone to bias, as people generally tend to appear healthier than they really are by over-reporting

the healthy foods and under-reporting the unhealthy foods eaten (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995). It cannot be ruled out that this also occurred in this study. However, since each student acted as his/hers own control, a possible healthy over-reporting would most likely be the same on the two test days.

Conclusion

It was clearly shown that a medium- or high-protein breakfast decreased the hunger ratings lunch compared with a control breakfast. A dose-response relationship related to the consumed amount of pork sausages was also observed. However, there was no direct link between hunger ratings and actual energy intake at lunch. The self-reported snack intake during the whole day showed no significant relationship with the breakfast consumed.

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