The appetizing effect of an apéritif in overweight and
normal-weight humans

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ABSTRACT

Background: Epidemiologic studies have shown alcohol consumption to be inversely as well as positively related to body weight and body fat. Metabolic studies have shown an increase in energy intake as well as compensation after alcohol consumption.

Objective: Our objective was to assess the effects on energy intake of an apéritif compared with those of a water appetizer and 3 fruit juice appetizers.

Design: Fifty-two men and women aged 20–45 y with a body mass index (in kg/m²) between 20 and 32 were randomly given 1 MJ (340 mL) alcohol (wine or beer), fat (cream fruit juice), protein (protein fruit juice), carbohydrate (grape juice), or water, or no preload 30 min before an ad libitum lunch consumed from the universal eating monitor.

Results: Energy intake (3.5 ± 0.3 MJ compared with 2.7 ± 0.2 MJ, P < 0.001) and eating rate were higher (44 ± 3 g/min compared with 38 ± 3 g/min, P < 0.01), meal duration was longer (14 min compared with 12.0 min, P < 0.01), satiation started to increase later (3.5 min compared with 1.5 min, P < 0.01), and eating was prolonged after maximum satiation (2.5 min compared with 0.6 min, P < 0.01) after an apéritif than after a fat, protein, or carbohydrate appetizer. Twenty-four-hour energy intake was higher on a day that an apéritif was consumed than after water or no preload.

Conclusion: Twenty-four-hour energy intake was elevated with a 1-MJ apéritif but not with a 1-MJ liquid carbohydrate, fat, or protein appetizer.

KEY WORDS Macronutrients, alcohol, preloads, universal eating monitor, appetite, satiety, energy intake, energy intake compensation, humans, apéritif

INTRODUCTION

Different macronutrients have different satiating efficiencies, i.e., protein is most satiating, followed by carbohydrate and fat, and thus exert different effects on appetite regulation (1–14). Moreover, the priority in satiating efficiencies of the macronutrients has a metabolic component as well (15–21). Thus, body weight regulation is affected differently by the different macronutrients. However, not much is known about the effects of alcohol on hunger, satiety, and subsequent food intake in relation to body weight. Is appetite influenced by alcohol consumption and does the body recognize alcohol-derived energy and regulate its intake as it does for the other macronutrients? These questions have been addressed in epidemiologic, energy metabolism, and food intake studies.

Epidemiologic data suggest that in women there is an inverse relation between body mass index (BMI; in kg/m²) and alcohol intake at intakes ≤ 50 g/d (22–25). At higher intakes of alcohol, BMI increases (22–24). In men, there is no such relation. Across a wide range of alcohol intakes, men have similar BMIs. However, another epidemiologic study showed that alcohol correlated positively with body fatness, and it was thus concluded that alcohol consumption might be an important factor in body weight gain (26). In contrast, a well-controlled metabolic study showed that the long-term addition of alcohol to the diet results in no additional weight gain, whereas adding the same amount as chocolate resulted in large weight gains (27). In that study, replacing dietary carbohydrate with alcohol resulted in weight loss.

Epidemiologic studies of alcohol intake in relation to total energy intake have shown that in moderate alcohol consumers total energy intake increases when alcohol is introduced into the diet (28–32). This suggests that alcohol-derived energy is additive and not recognized or regulated by the body; it does not replace energy from other substrates. Appetite seems to remain unchanged, and no compensatory decrease in the subsequent amount of food eaten was reported.

In a controlled food intake study, Tremblay et al (33) reported that when alcohol is consumed during a meal, its energy content is not compensated for by an equivalent decrease in energy intake from other macronutrients, and thus, total energy intake increases. Also, no compensation for alcohol added to the daily menu (34) or given as a preload (35) was found. In contrast, it has been concluded that alcohol-derived energy appears to be under normal physiologic regulation, decreasing food intake in a manner similar to that of isoenergetic carbohydrate sources (36).

Studies investigating the role of alcohol in relation to energy metabolism showed no greater diet-induced thermogenesis (DIT)
after ingestion of alcohol than after carbohydrate or fat (37–41). This is contrary to the findings of Suter et al (42), who showed that the DIT of alcohol is equivalent to ≈20% of its energy content, which is larger than that of carbohydrate (43). Alcohol is oxidized first, as a mode of detoxification, which inhibits the oxidation of other substrates, especially fat (37, 40, 42, 44).

No general view about alcohol metabolism has been developed within any approach focused on body weight, energy intake, or energy metabolism. The so-called futile cycle may be an explanation for alcohol being additive to energy intake in relation to its metabolism and the inability of the body to store it (45, 46). The futile cycle uses an irreversible oxidation of alcohol to acetaldehyde and a reduction of acetaldehyde to alcohol that can dissipate 6 ATP per cycle, thus eliminating any net gain of alcohol energy after a few cycles.

Most of the studies mentioned have focused on possible compensatory energy intake reduction after alcohol consumption, or, if there was no compensatory intake, on possible metabolic inefficiency. Alcohol, when consumed as an apéritif, is generally expected to stimulate food intake, which might be expected to result in relatively higher energy intakes, derived from the alcohol itself as well as from the subsequent meal. In addition to altering the development of satiation while a meal is being consumed, alcohol may disturb control over meal size (47).

We investigated the effects of a usual apéritif (wine or beer) in comparison with those of water and isoenergetic, isovolumetric appetizers containing fat, protein, and carbohydrate (all fruit juices with similar tastes) on the short-term appetite profile and subsequent energy intake in normal-weight and overweight men and women. The preload-meal interval of 30 min was tested by using a milk shake as a preload (48). An ad libitum lunch from the universal eating monitor was offered 30 min after each liquid appetizer was consumed (49, 50).

SUBJECTS AND METHODS

Subjects

Fifty-two healthy men and women aged 20–45 y were recruited through the local and university newspapers. Their degrees of dietary restraint were determined by the Three-Factor Eating Questionnaire (51) and the Herman-Polivy restraint scale (52). Anthropometric measurements took place with subjects in the fasted state. Body weight was measured by using a digital scale accurate to 0.01 kg (type E1200; Sauter, Ebingen, Germany) and height was measured to the nearest 0.001 m. BMI was calculated as body weight (kg) divided by height (m) squared. Subject characteristics are given in Table 1. Subjects were fully informed about the study and gave their written, informed consent. The study was approved by the Medical Ethical Committee of the Academic Hospital, Maastricht University.

Procedures

Two types of observations took place before the actual experiments started. First, to check whether a 30-min interval between the preload and the test meal was effective, 2 appetizers were offered randomly to all subjects on 3 occasions: a milk shake preload (53%, 11%, and 36% of energy as carbohydrate, protein, and fat, respectively), which was large enough (340 mL, 1.3 MJ) to have a possible effect on subsequent energy intake (48); an isovolumetric water preload; and no preload. Therefore, the subject

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Subject characteristics¹</th>
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<tr>
<td></td>
<td>Women n = 15</td>
</tr>
<tr>
<td>Age (y)</td>
<td>26 ± 4</td>
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<tr>
<td>Body mass index (kg/m²)</td>
<td>21 ± 2</td>
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<tr>
<td>Factor 1 (cognitive restraint)</td>
<td>6 ± 1</td>
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<tr>
<td>Factor 2 (disinhibition)</td>
<td>4 ± 2</td>
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<tr>
<td>Factor 3 (hunger)</td>
<td>3 ± 1</td>
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¹ ± SD. TFEQ, Three-Factor Eating Questionnaire (51). For Herman-Polivy restraint and TFEQ scores a higher value indicates more restraint, disinhibition, etc. ²Significantly different from normal weight, P < 0.01 (Mann-Whitney U test).
each drink showed a sufficiently high hedonic value (median: 69 mm; range: 59–80 mm), with no significant differences between the drinks. The median sweetness value for all drinks was 51 mm and the range was 33–68 mm; the wine scored relatively low (median: 37 mm; range: 33–41 mm), as did the beer (median: 39 mm; range: 35–43 mm). The median sourness for all drinks was 29 mm and the range was 22–36 mm, with wine scoring higher than the other drinks (median: 43 mm; range: 40–46 mm). The median saltiness value was 11 mm; the range was 8–14 mm. The median bitterness value was 19 mm and the range was 16–22 mm for all drinks except beer, for which it was 51 mm with a range of 42–60 mm. Thus, it appeared that the fruit juices tasted similar to each other, the wine was relatively sour and less sweet, and the beer was relatively bitter and less sweet. Despite these differences, all drinks showed a similar, sufficiently high hedonic value.

After these 2 observations, the experiment with the 5 different macronutrient-containing apéritifs was started. The subjects came 5 more times to the department for a liquid appetizer (the type of appetizer was given in random order) and lunch in 5 consecutive weeks, on the same day of the week and at the same time of the day. Thirty minutes after finishing each drink, which took 5–10 min, the subjects were offered a 650-g homogeneous cold salad for lunch, ad libitum: cold, boiled pasta; French beans; peas; corn; ham; lettuce; tomato; parsley; chives; and dressing (olive oil, vinegar, salt, pepper, mustard, sugar, and thyme). The amount offered was such that there were always leftovers on the plate. The energy density was 6.44 kJ/g and the macronutrient composition was 64% of energy as carbohydrate, 18% as protein, and 18% as fat. The salad was offered from the universal eating monitor (50), ie, a scale built into a table and connected to a digital computer that records the weight every time the scale is at rest again. The subjects were informed about this monitor, which was not expected to disturb their eating behavior (50). The observer, who was not visible to the subject, recorded a score every time a bite was taken, on a computer connected to the universal eating monitor so that each bite was recorded in connection with the change in weight (bite size) at the time at which it occurred (53). This way, meal size, duration, eating rate, and possible change in eating rate could be observed (50, 53).

The appetite profile, ie, ratings of hunger, satiety, desire to eat, and comfort were recorded on 100-mm VAS (anchored for each with “not at all” and “very much”) before and after the preload, before and after lunch, 2 and 4 h after lunch, before and after dinner, and 2 and 4 h after dinner. Moreover, in relation to a possible effect of alcohol, lightheadedness, sleepiness, relaxation, excitement, and feeling warm were recorded on 100-mm VAS (anchored for each with “not at all” and “very much”) after the preloads and after the meal. Also, after the meal, the hedonic rating of the meal (100-mm VAS anchored with “not very good” and “very good”) and the amount eaten compared with the usual amount (100-mm VAS anchored with “much less” and “much more”) were recorded. Every 2 min during the meal, satiation was recorded on 100-mm VAS anchored with “not at all” and “very much.” After the alcohol preloads the subjects were not allowed to depart for 3 h unless they went by taxi.

Energy intake during the rest of the day was recorded in food intake diaries as accurately as possible by the subjects using household measures, as instructed by a dietitian. The food intake diaries were analyzed by using the NEVO table (54).

Data analysis

Data for men and women were analyzed separately. Energy intakes at lunch and during the rest of the day, as well as the different VAS ratings, were compared between the following conditions: alcohol preload (wine) and alcohol preload (beer), alcohol preload (wine) and carbohydrate preload (grape juice), protein preload (protein fruit juice), fat preload (cream fruit juice), water preload, and no preload; and alcohol preload (beer) and carbohydrate preload, protein preload, fat preload, water preload, and no preload. Moreover, we calculated to what extent possible energy intake compensation took place for the energy consumed as a preload. Meal duration and eating rate were also compared between the above-mentioned conditions. The cumulative food intake curves were described by means of curve fitting (Cricket Graph III.1.5; Computer Associates International Inc, Islandia, NY).

Satiation during the meals appeared to increase from a short time after the start to a short time before the end of the meal. The time until the increase in satiation, the rate of increase, and the time subjects spent eating after the maximum were compared between the above-mentioned conditions. For the comparisons mentioned, analysis of variance (ANOVA) with repeated measures was used. Post hoc, for each comparison separately, ANOVA with repeated measures was also used. Scheffe F values are given (STATVIEW+GRAPhICS; Abacus Concepts, Inc, Berkeley, CA).

RESULTS

Because the energy intake data differed significantly between the men and the women ($F_{[1,50]} = 6.2, P < 0.001$), these results are given for the men and women separately. Within the groups of men and women, the data did not differ significantly between the overweight and normal-weight subjects: women ($F_{[1, 26]} = 1.1,$
P > 0.1) and men (F_{1.26} = 1.3, P > 0.1). Therefore, these results are taken together for the normal-weight and overweight men or women. Also, because the VAS ratings for hunger, satiety, desire to eat, and comfort did not differ among any of the subject categories, the whole group of subjects was analyzed together.

**Energy intake**

Energy intake during lunch did not differ significantly between the 2 alcohol preload conditions in the men or women (Figure 1). Energy intake during lunch was significantly greater after the alcohol preloads than after the carbohydrate, protein, or fat preload in the men (F_{(4,92)} = 16.2, P < 0.001) and in the women (F_{(4,100)} = 18.4, P < 0.001). Energy intake during lunch did not differ significantly after the alcohol preloads compared with after the water preload or after no preload in both the men and the women (Figure 1). Total energy intake (preload plus lunch) was greater with any of the 5 appetizers (from 3.4 ± 0.2 to 4.2 ± 0.3 MJ in the women and from 4.0 ± 0.3 to 4.9 ± 0.4 MJ in the men) than with water or no preload [2.7 ± 0.2 MJ in the women (F_{(6,150)} = 10.1, P < 0.001) and 3.3 ± 0.3 MJ in the men (F_{(6,138)} = 9.8, P < 0.001)] (Figure 2 and Figure 3).

Twenty-four–hour energy intake was higher on a day that an alcohol preload was consumed than on a day with water or no preload (P < 0.05). On the days with the other energy-containing preloads, energy intake was lower than on days with alcohol and higher than on days with water or no preload, but not significantly so (Figures 2 and 3).

The hedonic values of the lunch were similar each time (81 ± 6 mm). Subjects reported eating more than usual after the aperitifs, ie, 18 ± 4% more after the nonalcoholic preloads and 34 ± 6% more after the alcohol preloads (F_{(6,306)} = 4.7, P < 0.001).

**Energy intake compensation**

Energy intake compensation during lunch after the carbohydrate, protein, or fat preload, compared with energy intake after the water preload (expressed as a percentage of the energy content of the preload) was on average 31 ± 4% in the women and 32 ± 7% in the men. Energy intake compensation after the alcohol preloads was on average −45 ± 8% in the women and −55 ± 9% in the men. During lunch, as mentioned in the previous section, energy intake was only significantly different after alcohol than after the other energy-containing preloads.

Energy intake during the rest of the day did not differ significantly among the different conditions with energy-containing preloads (Figures 2 and 3). Energy intake compensation (compared with energy intake after the water preload) after the energy-containing preloads (during lunch and the rest of the day) in the men was −40 ± 6% for the wine preload, −82 ± 9% for the beer preload, 32 ± 5% for the carbohydrate preload, −11 ± 3% for the fat preload, 62 ± 8% for the protein preload, and 56 ± 7% for the milkshake preload (Figure 2). In the women these values were −40 ± 5% for the wine preload, −61 ± 7% for the beer preload, 31 ± 4% for the carbohydrate preload, 0 ± 3% for the fat preload, 71 ± 8% for the protein preload, and 63 ± 7% for the milkshake preload (Figure 3).

As mentioned in the previous section, 24-h energy intake was highest on the days with alcohol preloads, which only differed significantly from 24-h energy intake on days with a water or no preload. Twenty-four–hour energy intake on days with nonalcohol, energy-containing preloads was in between, and differences from 24-h energy intake with water, no preload, or alcohol preloads, were not significant.

The macronutrient composition of the food consumed during the rest of the day did not differ among the different preload conditions for women and men, respectively: 46% and 43% of energy as carbohydrate, 19% and 18% as protein, 31% and 35% as fat, and 4% and 4% as alcohol.

**VAS ratings**

In the whole group, the VAS ratings of hunger, satiety, and desire to eat from before the preload until the end of the day...
showed the following significant differences among the different preloads (Figure 4 and Figure 5: the ratings of desire to eat were similar to the hunger ratings, so these are not depicted). Hunger and desire to eat were greater and satiety was less after the water preload and after no preload than after the other preloads ($F_{[6,306]} = 3.8, P < 0.05$). Also, hunger and desire to eat were less after the protein preload ($F_{[6,306]} = 2.9, P < 0.05$) than after the other preloads. In general, the subjects felt comfortable (83 mm on a 100-mm comfort VAS); there were no significant differences among the different preloads.

The other VAS ratings after the preloads were as follows: lightheadedness, 11 mm; and feeling warm, 40 mm. After the subsequent meal the VAS ratings were as follows: lightheadedness, 12 mm; and feeling warm, 46 mm. After the alcohol preloads the lightheadedness score was 68 ± 6 mm in men ($F_{[6,138]} = 18.2, P < 0.001$) and 76 ± 5 mm in the women ($F_{[6,150]} = 21.3, P < 0.001$); 30 min after the subsequent meal it was 52 ± 5 mm ($F_{[6,138]} = 13.5, P < 0.001$) in the men and 63 ± 6 mm ($F_{[6,150]} = 16.4, P < 0.001$) in the women, all compared with the other preloads.

**Meal duration and eating rate**

Eating rate was higher after the alcohol preloads (41 ± 2 and 47 ± 3 g/min in the women and men, respectively) than after the other macronutrient-containing preloads [35 ± 2 g/min in women ($F_{[6,150]} = 7.2, P < 0.001$) 41 ± 2 g/min in men ($F_{[6,138]} = 6.9, P < 0.001$)], whereas eating rates did not differ significantly after water and no preload (38 ± 2 and 44 ± 3 g/min in women and men, respectively). Meal duration was longer after the alcohol preloads (12.9 ± 0.4 and 14.8 ± 0.5 min in women and men, respectively) than after the other macronutrient-containing preloads [11.1 ± 0.4 min in the women ($F_{[6,150]} = 5.8, P < 0.001$)] and 13.0 ± 0.5 min in the men ($F_{[6,138]} = 4.7, P < 0.001$), whereas meal duration did not differ significantly after water and no preload (12.0 ± 0.4 min in the women; 13.4 ± 0.5 min in the men).

**Satiation**

Satiation curves (Figure 7) and cumulative food intake curves showed that satiation started to increase later after an alcohol-containing preload than after the other macronutrient-containing preloads [women: 3 ± 0.5 min compared with 1 ± 0.3 min ($F_{[6,150]} = 8.8, P < 0.001$); men: 4 ± 0.5 min compared with 2 ± 0.3 min ($F_{[6,138]} = 7.7, P < 0.001$)], and meal duration was prolonged after satiation had reached its maximum [women: 2 ± 0.5 min compared with 0.3 ± 0.3 min ($F_{[6,150]} = 8.4, P < 0.001$); men: 3 ± 0.5 min compared with 0.8 ± 0.3 ($F_{[6,138]} = 7.2, P < 0.001$)]. The VAS ratings of satiety at the start (38 ± 4 mm) and at the end of lunch (89 ± 3 mm) did not differ significantly among the 5 different conditions with a 1-MJ preload.

**FIGURE 4.** Mean (±SD) visual analogue scale (VAS) hunger ratings from before the preload until the end of the day ($n = 52$). *Water and no preload significantly different from other preloads, $P < 0.05$.

**FIGURE 5.** Mean (±SD) visual analogue scale (VAS) satiety ratings from before the preload until the end of the day ($n = 52$). *Water and no preload significantly different from the other preloads, $P < 0.05$.

**FIGURE 6.** Averaged cumulative amount ingested after the different preloads ($n = 52$). (SD range: ±2 to ±3 g ingested/min). The amount ingested after a beer or wine preload was significantly different from that after the other preloads, $P < 0.001$. mm. These values did not differ significantly among the preload conditions, except for the alcohol preloads for which lightheadedness was greater 30 min after the subsequent meal than for the other preloads. After the alcohol preloads the lightheadedness score was 68 ± 6 mm in men ($F_{[6,138]} = 18.2, P < 0.001$) and 76 ± 5 mm in the women ($F_{[6,150]} = 21.3, P < 0.001$); 30 min after the subsequent meal it was 52 ± 5 mm ($F_{[6,138]} = 13.5, P < 0.001$) in the men and 63 ± 6 mm ($F_{[6,150]} = 16.4, P < 0.001$) in the women, all compared with the other preloads.
The relatively larger meal size after the apéritifs was also accompanied by a different pattern of satiation. It appeared that satiation, which shows an increase a few minutes after the start of a meal (58), increased later after the apéritifs. Delayed satiation after the start of a meal has been explained as a positive feedback mechanism (58, 59). Second, it appeared that eating continued longer after satiation had reached its maximum value with the apéritifs. The only significant difference in the VAS ratings, which might contribute to an explanation for this, was lightheadedness, which was significantly greater after the apéritifs even 30 min after the meal was finished. Therefore, it might be that the increase in eating rate and meal duration (resulting in higher food intake) was caused by a conscious or unconscious attempt to reduce lightheadedness.

When these results are compared with results reported in the literature, the first obvious difference is with the observations reported by Poppitt et al (35). They did not find a difference in energy intake after an alcohol and a carbohydrate preload compared with that after a water preload. Their preload size was smaller (0.72 MJ for the carbohydrate preload and 0.91 MJ for the alcohol preload), and they offered a 2-course meal, during which intakes during the different courses might have compensated for each other. Overall, the meal sizes they reported were bigger than the ones we report, despite the same energy densities, probably because of the 2 courses.

During the rest of the day, energy intakes no longer differed significantly, which resulted in negative energy intake compensation over a day after alcohol consumption before lunch. This observation does not confirm the compensation after alcohol consumption reported by Foltin et al (36). In accordance with the observations reported by Mattes (34), we also conclude that in general, energy intake compensation for liquids is incomplete. Therefore, liquids represent an easy way to ingest energy, whether to make up for a negative energy balance, for instance with endurance sports, or in the case of a positive energy balance as in the development of obesity.

Our results are also in line with observations that showed that in moderate alcohol consumers, total energy intake increases when alcohol is added to the diet (28–35), suggesting that alcohol-derived energy is additive and not recognized or regulated by the body; thus, it does not replace other energy substrates. Appetite seems to remain unchanged and no compensatory decrease was reported in the subsequent amount of food eaten. We cannot draw a conclusion about possible metabolic inefficiency because we did not measure energy expenditure or substrate utilization. Thus, we also cannot suggest what the effect on body weight would be. From this study we conclude that alcohol may increase appetite when consumed as an apéritif. It stimulated food intake, which resulted in a relatively higher energy intake during the subsequent meal in comparison with an isenergetic, isovolumetric, nonalcoholic appetizer; there was no compensation during the rest of the day. This difference is related to the different satiating effects of the different macronutrients (there was partial energy intake compensation for protein, carbohydrate, and fat) in comparison with the nonsatiating effect of alcohol. Apart from the energy intake provided by the alcohol-containing drink, increased energy intake from the meal also occurred. Subjects were lightheaded after alcohol consumption, which might have had a disturbing effect on control of the size of the subsequent meal, and thus contributed to the short-term lack of energy intake compensation. Lack of energy intake compensation for alcohol later during the day was probably caused by the lack of a satiating effect in the postabsorptive state.

Thus, 24-h energy intake after the high-fat, high-protein, or high-carbohydrate preloads did not differ significantly from that after alcohol (being higher), or water or no preload (being lower). However, 24-h energy intake was higher on a day that an apéritif was consumed than on a day with water or no preload.
We thank the Hertog Jan Brewery for providing the beer for this study.

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