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Effect on gastric function and symptoms of drinking wine, black tea, or schnapps with a Swiss cheese fondue: randomised controlled crossover trial

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ABSTRACT

Objective To compare the effects of drinking white wine or black tea with Swiss cheese fondue followed by a shot of cherry schnapps on gastric emptying, appetite, and abdominal symptoms.

Design Randomised controlled crossover study.

Participants 20 healthy adults (14 men) aged 23-58.

Interventions Cheese fondue (3260 kJ, 32% fat) labelled with 150 mg sodium ^{13}Carbon-octanoate was consumed with 300 ml of white wine (13%, 40 g alcohol) or black tea in randomised order, followed by 20 ml schnapps (40%, 8 g alcohol) or water in randomised order.

Main outcome measures Cumulative percentage dose of ^{13}C substrate recovered over four hours (higher values indicate faster gastric emptying) and appetite and dyspeptic symptoms (visual analogue scales).

Results Gastric emptying was significantly faster when fondue was consumed with tea or water than with wine or schnapps (cumulative percentage dose of ^{13}C recovered 18.1%, 95% confidence interval 15.2% to 20.9% *v* 7.4%, 4.6% to 10.3%; P<0.001). An inverse dose-response relation between alcohol intake and gastric emptying was evident. Appetite was similar with consumption of wine or tea (difference 0.11, −0.12 to 0.34; P=0.35), but reduced if both wine and schnapps were consumed (difference −0.40, −0.01 to −0.79; P<0.046). No difference in dyspeptic symptoms was present.

Conclusions Gastric emptying after a Swiss cheese fondue is noticeably slower and appetite suppressed if consumed with higher doses of alcohol. This effect was not associated with dyspeptic symptoms.

Trial registration ClinicalTrials.gov NCT00943696.

INTRODUCTION

Claims about the benefits or otherwise of drinking alcoholic beverages with food, especially high fat and high energy meals such as cheese fondue, are conflicting. In Switzerland, some traditionalists demand that white wine is drunk with this classic winter dish, whereas others insist that only black tea is appropriate. The debate continues after dinner as to whether a shot of "spirits" will promote digestion and digestive comfort. The evidence base is weak; however, grave concerns about the correct choice of beverage seem to exist. For example, a questionnaire study indicated that respondents anticipated severe side effects from drinking Coca Cola with fondue, ranging from dyspepsia to death.[1]

In physiological studies using a variety of test meals and drinks the evidence for the effects of alcohol on gastric emptying have been inconsistent.[2-6] Similarly, alcohol has complex effects on appetite and the likelihood of experiencing abdominal discomfort after a meal.[7] Critically, only one study has assessed both gastric function and symptoms after alcohol ingestion[5] and none considered the effects of alcohol consumed with a high energy, high fat meal, such as one with melted cheese. The evidence is also limited by suboptimal measuring techniques, failure to monitor alcohol concentrations, and weak study design.

We compared the effects of white wine, black tea, and schnapps on gastric emptying and abdominal symptoms after ingestion of a Swiss cheese fondue in healthy volunteers using a randomised controlled crossover study design.

METHODS

We tested 20 healthy volunteers (14 men and six women; mean age 37.5 (23-58) years, mean body mass index 23.6 (18.3-32.9)) on two days, at least one week apart. None of the participants had a history of alcohol misuse or gastrointestinal disease. None were taking prescription drugs. Half (n=10) stated a preference for white wine with the fondue.

Test meal

After a minimum fast of six hours, the participants ingested 200 g of fondue made with Swiss cheese (3260 kJ, 64 g fat, 2 g carbohydrate, 52 g protein);

using 50% Gruyere cheese and 50% Fribourgeois cheese (Moite-Moite Fondue, Coop, Basel, Switzerland) labelled with 150 mg sodium ^{13}Carbon-octanoate. The cheese was heated using individual "rechauds" and consumed with 100 g of cubed dry bread (418 kJ). On each study day during the test meal the participants drank either 300 ml of white wine (Fendant de Valais (Coop, Basel), 40 g of alcohol, 13% by volume, 903 kJ) or 300 ml of black tea according to the randomisation protocol. At 90 minutes according to a balanced second randomisation the participants ingested either 20 ml of cherry schnapps (Etter Kirsch, Zug, Switzerland, 8 g of alcohol, 40% by volume, 234 kJ) or 20 ml of water.

^{13}C-octanoate and alcohol breath tests

Before the meal and every 10-15 minutes for four hours we collected samples for breath testing in 100 ml double aluminised bags. Participants remained seated to rule out the effects of movement on gastric function. We measured the isotopic ratio of ^{13}C to ^{12}C in breath test samples using isotope selective non-dispersive infrared spectrometry (IRIS; Wagner, Bremen, Germany). The proportion of administered substrate metabolised and exhaled was expressed as the maximal percentage dose of ^{13}C recovered per hour and the cumulative percentage dose recovered for each time interval.[8 9] Additionally, we used the reversed retention curve to fit individual data to estimate the half times for gastric emptying.[8]

Alcohol in breath was assessed before ingestion of the fondue and every 15 minutes for four hours with a standard breath test device (Draeger, Luebeck, Germany) used by traffic police to measure alcohol concentrations. To rule out artefacts the participants rinsed their mouths with 100 ml water before each test.

Visual analogue scales

For appetite we used a 100 mm visual analogue scale to assess hunger, satiety, desire to eat, and quantity to eat before the test meal and every 15 minutes for four hours. Similarly, we used a visual analogue scale to assess dyspeptic symptoms, nausea, bloating, and abdominal discomfort throughout the study.

Statistical analysis

Statistics and plots were produced with R (R 2005).[10] We separately analysed the data collected during the initial 100 minutes (immediately after ingestion of schnapps or water) and the data collected subsequently. Gastric emptying was evaluated by the cumulative percentage dose recovered after each time interval (larger values indicate faster emptying).[8] Results are presented as means with 95% confidence intervals. We normalised the scores for appetite, hunger, satiety, desire to eat, and quantity to eat by subtracting the group mean score and then dividing by the group standard deviations (for satiety, the sign was inverted to be comparable with the other sensations). A correction was applied for multiple pairwise comparisons.

RESULTS

Gastric emptying

From early during the meal and throughout the study the recovery curves for ^{13}C were lower for wine consumed than for tea, indicating slower gastric emptying. In addition, the recovery rate decreased immediately after ingestion of schnapps, which was most evident in association with tea (fig 1).

The cumulative percentage dose of ^{13}C recovered for each time interval confirmed that gastric emptying was significantly faster when fondue was consumed with tea or water than with wine or schnapps (18.1%, 95% confidence interval 15.2% to 20.9% *v* 7.4%, 4.6% to 10.3%; P<0.001). This equates to gastric emptying half times of 361 minutes (95% confidence interval 314 to 408 minutes) and 560 minutes (514 to 607 minutes), respectively. Gastric emptying was faster if fondue was consumed with tea rather than with wine, whether schnapps was consumed (increased cumulative recovery difference 7.0, 95% confidence interval 2.9% to 11.0%; P<0.002) or not (difference 8.1, 4.1% to 12.2%; P<0.001). Schnapps also tended to slow gastric emptying, especially when consumed after tea (decreased cumulative recovery −3.6%, 0.4% to −7.7%; P<0.075), equivalent to an increased gastric emptying half time of 80 minutes (95% confidence interval 15 to 145 minutes). An evident trend could be observed between the concentration of alcohol consumed and decreased rate of gastric emptying (fig 2).

Breath alcohol levels

After ingestion of the fondue meal with 300 ml of white wine, the levels of breath alcohol increased to 0.040% (SD 0.003%), falling to below 0.010% at the end of the study. Schnapps produced a brief increase in breath alcohol concentrations that did not exceed 0.02%. There was no correlation between breath alcohol concentration and the rate of gastric emptying and no

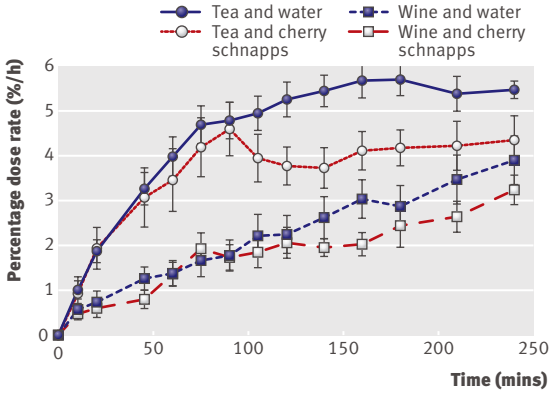


Fig 1 | Gastric emptying measured as average percentage dose recovery of carbon 13 (error bars show standard errors) after ingestion of cheese fondue taken with white wine or black tea followed by a shot of cherry schnapps

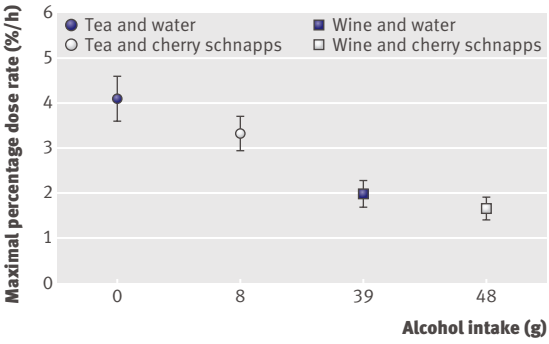


Fig 2 | Estimated mean values (95% confidence intervals) of maximal doses of ^{13}C recovered in breath. Larger values indicate faster emptying. An inverse relation is evident between amount of alcohol consumed and rate of gastric emptying

association between breath alcohol concentration and body mass index.

Appetite

Ingestion of the test meal increased fullness and decreased the appetite score by 0.33 (95% confidence interval 0.03 to 0.63; P<0.032). The effects of alcohol ingestion on appetite did not differ between meals consumed with wine or with tea (difference 0.11, 95% confidence interval −0.12 to 0.34; P=0.350); the desire to eat dessert was, however, reduced in the group that had consumed both wine and schnapps (appetite score decreased by 0.40, 95% confidence interval 0.01 to 0.79; P<0.046). There was no correlation between appetite score and rate of gastric emptying.

Dyspeptic symptoms

Five participants reported dyspeptic symptoms (nausea, bloating, discomfort) of moderate intensity (visual analogue scale score >3). Only one participant reported more severe symptoms (score >6). The low scores reported by most participants and the presence of outliers prevented meaningful statistical analysis of individual or composite scores between study conditions.

DISCUSSION

Cheese fondue is a meal served on festive occasions or when family and friends get together in Switzerland. It is also among the most popular dishes ordered by tourists in Switzerland; no skiing trip is complete without a fondue dinner! In terms of nutrient composition, Swiss cheese fondue is not much different from any other fondue; however, Swiss people will, of course, claim that it is the original and by far the best! Those familiar with local customs, perhaps having read the classic reference *Asterix in Switzerland*,[11] will know that there can be punishments for fondue eaters who lose their bread in the cheese, ranging from an extra shot of schnapps to being thrown into a freezing lake. This kind of psychosocial stress is likely to affect gastric function and could trigger dyspeptic symptoms.[12] In this study, the participants consumed fondue from individual "rechauds" so avoiding potential embarrassment to those less skilful with a fork. Moreover, in compliance with the stringent requirements of the local ethics committee, no punishments were threatened, or indeed meted out!

The debate about what to drink with a cheese fondue is one about which everyone at the Swiss dinner table has an opinion. Although the importance of this question to the "rest of the world" should not, perhaps, be overstated, the findings of this study can be generalised to address the wider issue of alcohol's effects on digestion and digestive comfort after any large, rich meal of the kind enjoyed by all over the festive season. This randomised controlled trial is an important contribution to this debate as it is the first to apply well validated and concurrent assessments of gastric emptying, alcohol concentrations, and postprandial symptoms. The results show that drinking white wine with a high fat, high energy meal such as Swiss cheese fondue decreases the rate of gastric emptying compared with black tea. Taking a shot of spirits after the meal has additional gastrointestinal effects. At the highest doses studied, alcohol seemed to suppress appetite after the meal; however, irrespective of beverage, dyspeptic symptoms were reported only occasionally by the healthy participants.

We observed an important decrease in gastric emptying rate when a moderate amount of white wine (300 ml; 14% alcohol) was consumed with a Swiss cheese fondue compared with the same volume of black tea. The decrease was both rapid and prolonged, with the recovery of ^{13}C reduced from the first breath sample and never attaining the level observed in the control arm (fig 1). This finding is consistent with reports that ethanol and a variety of alcoholic beverages slow gastric emptying when taken before a meal[4 6]; although, this effect was not always observed if the total energy content of food and drink consumed during the meal was controlled.[2 3] We chose not to control energy intake because this would have required 12 teaspoons of sugar. Tea sweetened to this extent is not palatable and the osmolality of sugar in solution is greater than that of alcohol. This would also slow gastric emptying and indeed might explain the divergent results of previous reports.[13 14] Comparison of our results with those of a dietary intervention study that controlled both energy and osmolality,[15] indicates that the approximate 25% increase in total energy intake is not sufficient to explain the approximate 50% decrease in gastric emptying rate that we observed when alcohol was consumed with fondue.

A shot of cherry schnapps (20 ml; 40%) taken after the Swiss cheese fondue also reduced the rate of gastric emptying. One previous paper did not show similar effects with brandy[5]; however, the assessment of gastric emptying by antral ultrasound applied in that study was confounded by any redistribution of the meal within the stomach or increase in gastric secretion that occurs with alcohol.[16] Again, the effect was rapid, with an immediate decrease in ^{13}C recovery observed after intake (fig 1). It is inconceivable that a small

WHAT IS ALREADY KNOWN ON THIS TOPIC

The effects of alcohol on gastric function, appetite, and abdominal symptoms are complex, depending on the characteristics of the drink and meal

Claims about the benefits or otherwise of alcohol intake with high energy, high fat meals are conflicting

Previous studies rarely assessed the effects of alcohol on gastric function and symptoms after a meal and none with a high energy, high fat meal

WHAT THIS STUDY ADDS

Gastric emptying is noticeably slower if alcohol rather than black tea is consumed with Swiss cheese fondue

A trend relating alcohol intake to a progressive decrease in gastric emptying was evident

Higher concentrations of alcohol consumed with or after a high energy meal may suppress appetite, but with no effect on digestive comfort

volume of spirits could "bypass" the solid meal in the distal stomach quickly enough to exert such rapid effects through feedback from nutrient receptors in the small bowel. Although a trend relating alcohol intake and gastric emptying rate was evident (fig 2), we found no correlation between the concentration of alcohol in the breath and the effects on gastric emptying. Together these observations support the hypothesis that alcohol has direct, rather than indirect or systemic effects, on stomach function. Direct relaxation of gastric wall musculature would suppress antral contraction waves that break down the meal and also inhibit the tonic "pressure pump" mechanism that drives gastric emptying.[15 17]

The effects of alcohol on appetite and abdominal symptoms are complex, depending on the timing, quantity, and other characteristics (for example, caloric load, palatability) of the drink and the meal.[7 18-20] In this study alcohol suppressed appetite, but this effect was apparent only at the highest concentration (48 g alcohol consumed as wine and schnapps). Although the energy density of alcohol is second only to that of fat, its effect on satiation seems to be less than that of other macronutrients.[7] When alcohol is consumed with food a dynamic balance exists between short term stimulation of appetite,[19 20] mid-term reduction in appetite due to slow gastric emptying with prolonged distension of the stomach,[21] and long term compensation to maintain energy balance.

Notwithstanding the concerns of traditionalists,[1] we found no association between beverage consumed during the meal and dyspepsia after the meal in healthy volunteers. Impaired gastric relaxation (accommodation) has been associated with early satiety and discomfort after meals in patients with functional dyspepsia; whereas slow gastric emptying has been associated with prolonged fullness, nausea, and vomiting.[22] Alcohol promotes gastric relaxation but delays gastric emptying. As a consequence, drinking white wine and schnapps with a Swiss cheese fondue may provide short term relief of postprandial dyspepsia; this may, however, come at the cost of more prolonged fullness (the feared "cheese baby" syndrome) and reflux.

Limitations of the study

In common with other real life dietary interventions the limitations of this study are the inability to fully blind or control for both energy load and osmolality. White wine was consumed cold and tea warm and this may have had some effect on stomach function.[23 24] Some connoisseurs will point out that wine or schnapps is often added to cheese fondue during preparation; this would not, however, confound the results because, as noted by James Peterson, a cookbook writer who studied chemistry at the University of California at Berkeley, as alcohol boils at 78°C it will be evaporated in sauces simmered for more than 20-30 seconds.[25]

Finally, although alcohol slows gastric emptying, a prokinetic effect of black tea may also be present. Animal experiments have shown that a hot water extract of black tea (Camellia sinensis) promotes gastric emptying in rats, possibly as a result of inhibition of nitric oxide mediated relaxation of the stomach by thearubignins and theaflavins.[26]

Conclusion

This study shows that gastric emptying is noticeably slower if white wine rather than black tea is consumed with a Swiss cheese fondue. Healthy readers should be reassured that they can continue to enjoy this traditional meal with the beverage of their choice without undue concern about postprandial digestive comfort.

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Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no authors had financial support for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work. The authors confirm their independence from the funders.
Ethical approval: This study was approved by the Zurich University Hospital research ethics committee.
Data sharing: Full study data including statistical analysis and technical appendix are available from the corresponding author at dr.mark.fox@gmail.com.

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