

Meals and movies: making our microbiota merry

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Abstract

Objective: To investigate the impact of festive cinematic diets on the gut microbiota.

Design: Observational (watching films) and creative review. Sadly, we couldn't incorporate any snowball sampling.

Setting: In front of a television, by a blazing log fire.

Participants: Everyone: you don't need to be on the nice list!

Main outcome measures: Microbiota INdex of Comparative Evaluation for Pictorial Infographic Evidence (MINCE PIE) scores (difference between the numbers of microbiota-enhancing and microbiota-detrimental food groups) for foods depicted in twelve festive films.

Results: Most festive films featured meals or foods from a typical Western diet, with high sugar and fat content, with overall negative effects on the microbiota. However, some films promoted options containing fibre, beneficial proteins, or polyphenols. These are gifts under the Christmas tree for our microbiota.

Conclusion: Good balance is needed for our microbiota, and consequently our mental health. Many festive films portray a Western diet that can lead to dysbiosis. Through their action on the gut–brain axis and the influence of media on dietary choices, the festive foods consumed in these films (maybe an extra chocolate biscuit during *Love Actually*) can be stressful for our microbiota.



Our microbiota, the microorganism community in our gastrointestinal system,^{1,2} is thought to include as many as 1×10^{14} microorganisms from across 1000 species.^{2,4} Like a choir of angels in harmony, our gut microbiota work to regulate gut inflammation, metabolism, and digestion, with a variety of negative and positive health effects.^{1,2}

Many of us overindulge during the festive season, but gut health is important, as microbiota diversity influences the incidence of inflammatory conditions.¹ Further, changes to the composition of the microbiota appear to be risk factors for neurodegenerative diseases.⁵

Like snowflakes falling on A&E doors, each person has a unique microbiota composition that is influenced by a range of factors,³ including diet;¹ high levels of fat or sugar, diets rich in red meat, food additives, and everything we love at Christmas alter the composition of our microbiota, often increasing the abundance of inflammation-promoting bacteria.^{1,4,6}

Every turkey needs its trimmings, every doctor needs their patient, and every brain needs its gut. The gut–brain axis is a two-way system connecting the gastrointestinal tract with the emotion centres of the brain and associated pathways,^{2,3} and the gut microbiota modulate the gut–brain axis.⁵ Microbiome–brain–gut axis dysfunction is associated with a range of neuropsychiatric disorders, including, ironically, two common intruders during the festive season: depression and anxiety.^{2,7}

Several pathways have been implicated in the effects of gut microbiota on the gut–brain axis, including immunological, endocrine, neural, and microbial factors.^{2,3,5,8} Microbiota-produced mediators are also linked with neuropsychiatric health,

modulating the release of oxytocin, which influences social behaviour (eg, kissing under the mistletoe), and the neurotransmitter dopamine, implicated in the reward and motivation systems⁵ we all need during the long dark nights of the festive period.

The microbiota are like Santa: if you're on the Nice List (you have a healthy microbiota community), it's the gift that keeps on giving. But if you're on the Naughty List — expect a lump of coal.

The other great Christmas tradition is enjoying a film. Cinema has a noteworthy impact on our behaviour. While we may not take to the skies pulled by eight reindeer, film can influence many behaviours, and our diet, with effects ranging from overeating to altered food preferences.^{9–11} As already noted, dietary intake has a significant influence on the gut microbiota and, in turn, on mental health.

Bringing together some of the great Christmas activities — sitting, watching, and eating — we therefore explored the impact of festive cinematic diets on the gut microbiota.

Methods

To identify a representative sample of films, we searched for Christmas films in Google, then compared the top results with a "top 25 Christmas films" list on the IMDb website.¹² We included the films that appeared in both lists. We then searched Google to identify which of these films featured iconic or prominent foods, and excluded any without obviously featured items. Finally, we identified the most prominent foods in each film.

Food processing

We assessed the food items according to their main constituents; if not explicitly clear, we extrapolated data from simple recipes. For chocolate biscuits, for example, the main constituent was deemed to be chocolate; a basic biscuit recipe included flour, butter, eggs, and sugar. To judge the relative microbiota support offered by each festive meal, we used the numbers of microbiota-detrimental food groups (MDFGs) and microbiota-enhancing food groups (MEFGs) in the constituents to calculate the Microbiota INdex of Comparative Evaluation for Pictorial Infographic Evidence (MINCE PIE) score (= MEFG – MDFG).

A lower MINCE PIE score indicated a greater negative effect for the microbiota. No offence is intended to regular mince pie consumers. No statistical software was needed for our analysis. We used leftover wrapping paper donated by Santa to write up our calculations and to allocate foods to the Naughty or Nice Lists. When the effect of a food was unclear, the two authors reviewed the literature and reached a consensus. We hope this adds us to Santa's Nice List. Constituents without known effects or for which there was no relevant literature were scored as zero.

Ethics approval

Formal ethics approval was not sought for this study. As it was conducted during summer, we didn't feel it ethical to force an internal review board to start thinking about Christmas shopping before they had to. No animals, including red-nosed reindeer, were used in this study. No human or non-human creatures (eg, elves, snowmen, fairies) were involved in the study. Given the communication difficulties associated with working with the microbiota and in contacting Hollywood actors, we were unable to include co-production as part of the study design.

Results

Of the fourteen films identified by our search, two (*Miracle on 34th Street*, *The Nightmare before Christmas*) were excluded because

they did not feature food prominently. The MINCE PIE scores for each of the festive foods in the selected films are presented in the [Box](#). Foods with negative values (ie, detrimental to the microbiota) narrowly outnumbered those with positive values (ie, beneficial for the microbiota) seven to six; eggnog received a zero score (ie, neutral).

Discussion

Let's talk about the reindeer in the room ... We identified a marked pattern in the processed foods seen in the top festive films: according to their MINCE PIE scores, most would have mild, but often negative effects, on the microbiota. The festive film food most detrimental for microbiota health were Twinkies (seen in *Die Hard*), because of their high sugar content.

Sugar and spice to make Christmas nice ... or not. Unfortunately, diets high in refined sugar reduce microbial diversity and increase gut permeability.^{14,16,21} In addition, sugar alters the balance of microbial populations; for example, it increases Proteobacteria abundance and reduces that of Bacteroidetes species,^{15,21} resulting in a pro-inflammatory state and impairing immune and regulatory responses.²¹ Interestingly, there is evidence that sugar may not be all bad, as reducing the abundance of Bacteroidetes species is associated with activation of CD4⁺ T cells.¹⁴⁻¹⁶ Further, artificial sweeteners may be even more detrimental to the microbiota.^{1,15} Nonetheless, excessive consumption of Twinkies is not advisable.

Tiny Tim would be pleased to know that the food with the highest score for beneficial microbiota effects was the Christmas dinner in the *Muppet Christmas Carol* (MINCE PIE: +4). This is related to its high vegetable content, resistant starch, and relatively low sugar and fat content. Evidence for the effect of turkey itself was not available, but animal protein from white meat, such as chicken, has beneficial effects for the microbiota, increasing the abundance of *Bifidobacterium* species, for example, which strengthens the gut mucosal barrier.^{4,13,15}

The festive fight to the top of the tree: MINCE PIE scores for twelve festive films

| Film title | Food | MINCE PIE score | References (for food) |
|--|---------------------------|-----------------|-------------------------|
| <i>The Muppets Christmas Carol</i> | Christmas dinner | 4 | 4, 13–16, 19–23 |
| <i>A Christmas Carol</i> | Christmas pudding | 2 | 4, 13–16, 18, 19, 21–26 |
| <i>It's A Wonderful Life</i> | Mulled wine | 2 | 4, 15, 16, 24–26 |
| <i>National Lampoon's Christmas Vacation</i> | Turkey | 1 | 4, 13 |
| <i>Home Alone</i> | Mac and cheese | 1 | 1, 17, 18 |
| <i>Gremlins</i> | Chicken drumsticks | 1 | 4, 13 |
| <i>National Lampoon's Christmas Vacation</i> | Eggnog | 0 | 13–17, 21–24 |
| <i>Love Actually</i> | Chocolate biscuits | –1 | 13–18 |
| <i>Scrooged</i> | 5 lb veal | –1 | 4, 13–15 |
| <i>A Christmas Story</i> | Chinese "turkey" (duck) | –1 | 4, 6, 14, 15, 28 |
| <i>Elf</i> | Candy spaghetti breakfast | –1 | 4, 6, 14–18, 21 |
| <i>Bad Santa</i> | Candy corn | –1 | 14–16, 21 |
| <i>Home Alone</i> | Cheese pizza | –2 | 1, 14, 15, 18, 27 |
| <i>Die Hard</i> | Twinkies | –3 | 6, 13, 15, 18, 22, 23 |

Further details on of the scoring is available in the [Supporting Information](#). ♦

However, and hoping not to sound like Scrooge, too much of anything is never a good idea. For example, protein can be beneficial, but switching to a high protein diet may reduce the abundance of beneficial butyrate-producing bacteria, which is associated with increased risk of inflammatory bowel disease.^{4,15} Consequently, we really can't recommend the five pounds of veal offered in *Scrooge*.

Similarly, changes in the abundance of bacteria are not always as simple as naughty and nice. For instance, nuts are associated with a "prebiotic effect" (ie, promoting a healthy microbiota state), and this in turn is associated with increased Firmicutes numbers.⁴ However, increased abundance of Firmicutes together with fewer Bacteroidetes, as seen with high intake of saturated fats, may have a negative effect on our microbiota and changes to the Firmicutes–Bacteroidetes ratio are associated with disease.^{4,14}

Another bauble on our microbiota Christmas tree is the connection between microbiota health and mental health. Bacterial populations are altered in people with depression, with increased numbers of inflammation-inducing bacteria and fewer commensal bacteria.^{5,6,8} Changes in microbiota diversity have also been linked with conditions such as autism, anxiety, and neurodegenerative disease.^{5,6} Our diet, by causing dysbiosis of our microbiota, may influence these conditions. The Western diet, in particular, could be implicated in such dysbiosis.

Art reflects life, and life is influenced by art. The major focus of the festive media we viewed for our study was food. As a society we are influenced by the art we consume. The influence of film product placement has been reported; for instance, tobacco use in films is associated with greater likelihood of smoking by adolescents.⁹ This prompts the question: do foods in films have the same effect? It seems that whoever controls the remote during the festive period may have more power than they realise ... Certain film genres, such as action and horror, induce stress and anxiety.¹⁰ One study found that food preferences were also affected by film genre; sweet food preferences were enhanced by romantic films.¹⁰

Like a ride on the Polar Express, the gut–brain axis is a two-way system. Recent animal studies indicate that depletion of the microbiota impairs cognition and stress responses, resulting in depression-like behaviours.^{5,8} In addition, constant stress alters the composition of the microbiota and increases pro-inflammatory cytokine levels.^{3,8} This amplifies the two-way nature of the system, and changes to our microbiota may therefore be a cause or consequence of mental health disorders. Stress elicited by anxiety-inducing films may affect the microbiota, both directly and indirectly, by altering food preferences.

Finally, our microbiota balance is tightly regulated, and any overeating, particularly of the foods we have identified as deleterious, could lead to chronic gut stress. It has been reported

that viewers of films showing characters who are eating also eat more overall.¹¹ This finding is important, as long term consumption of a Western diet may lead to the extinction of beneficial microbes,⁴ and overeating will get us there faster than elves on Christmas Eve.

Limitations

Like a narrow chimney for Santa, our study has limitations. Firstly, the scientific literature did not always include evidence about specific constituents; we relied on the generic reports when specific evidence was unavailable. For example, evidence regarding white meat was used to assess turkey, and for specific subtypes of alcohol (eg, rum), generic evidence regarding the effects of alcohol was examined. In addition, the effects on microbiota of some foodstuffs have never been investigated.

Secondly, the relative volumes of foods were not taken into consideration; for instance, the benefits of polyphenols in chocolate may not be as great when its cocoa content is low. Thirdly, typical festive meal choices were assumed; for example, Kevin McAllister probably did not opt for a gluten-free, wholegrain pizza in *Home Alone*. The films did not include a great variety of food constituents, mostly reflecting a Western diet, leading to similar scores. Our simple scoring system did not take into account variability in the effect of a food on the microbiota, nor the effects of individual components, as the MINCE PIE score assessed each meal as a unit.

Conclusion

Like naughty and nice, good balance is the theme of our study: for our microbiota, for the effects of dysbiosis on our mental state, and in our festive entertainment habits. None of the meals we discussed should be eaten all the time, and five pounds of veal is unlikely to be received with joy at Christmas, no matter how microbiota-friendly.

Stress, whether induced by film viewing or last-minute gift shopping, is both a factor in and a result of changes to the microbiota. In the big picture, it is linked with mental health, for which microbiota balance is crucial. As joy is central to the festive season, whether strong positive emotions play as significant a role in microbiota gut–brain axis relationships as negative emotions should be investigated.

Perhaps if we find the right meal — one that has an impact on the gut microbiota that leads to improved health and happiness — we really could have a very merry Christmas!

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Supporting Information

Additional Supporting Information is included with the online version of this article.