International Journal of Gastronomy and Food Science 9 (2017) 10–15

Contents lists available at ScienceDirect

International Journal of Gastronomy and Food Science

journal homepage: www.elsevier.com/locate/ijgfs

Review Article

Tasting in the air: A review☆

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ARTICLE INFO

Keywords:
Airline food
Cabin pressure
Humidity
Noise
Umami
Gastrophysics

ABSTRACT

Many people complain about the taste and quality of airline food. Three of the key environmental factors that have been shown to play havoc with the passenger's ability to taste at altitude are the reduced cabin air pressure, the lack of humidity, and the loud background noise (of the plane's engines). In this review, after having outlined these and other problems that may adversely affect the tasting experience, I critically evaluate a number of the solutions that have been put forward over the years by the airlines, and others working in the field, in order to try and improve the situation. I also provide an explanation as to why it is that so many people drink tomato-based drinks while up in the skies, while rarely touching such drinks while down on the ground.

Introduction

That plane food normally tastes disappointing is something that most travellers would readily seem to agree upon (e.g., Smith, 2013a; cf. McGuire, 2015).[1] While once upon a time, increased competition in the skies led the airlines to compete on the quality of their cuisine (e.g., Berry, 2013; Foss, 2014; Kovalchik, n.d.; Xie, 2016), nowadays, at least in Economy Class (where the majority of passengers end up), the standard of food, if any is offered, appears to be getting worse. In order to try and address the perceived problem, many of the airlines have brought in their own nationally, or better-still internationally, famous celebrity chefs to help advise on the food served to those sitting in the premium cabins (de Syon, 2008; Pemberton, 2015; Severson, 2007; see Spence (2017), for a review). Generally-speaking, though, those airlines with the best-known chefs do not necessarily seem to find themselves any higher up on the annual rankings of airline food quality (e.g., Thornhill, 2015). Indeed, it never feels like one is getting the same experience that one would were one to be dining at one of the chef's flagship restaurants down on the ground (or, increasingly, in the airport terminal itself; see MacLeod (2014) and O'Ceallaigh (2014)), even if sitting in one of the premium cabins.[2]

So why *does* the food taste so bad in the air? And knowing about the latest findings from the emerging field of gastrophysics research (Spence, 2017) what, if anything, can be done to remedy the situation? These are particularly important questions given estimates that more than a billion passengers are serviced in the air each and every year (Jones, 2004, 2007). Most of the accounts that one reads about in the press concerning the parlous state of airline food tend to point the finger at the reduced cabin air pressure and the lack of humidity. While both of these factors undoubtedly play an important role in helping to explain what is going on, they are by no means the whole story. Indeed, the latest research now suggests that the sounds of the engines likely also plays an important role here too, suppressing our ability to both taste and smell (Spence et al., 2014; Yan and Dando, 2015). Beyond that, the stress and anxiety of the passengers, the light (low-quality) cutlery and glassware (Moskvitch, 2015), the lack of descriptive dish naming, and the lack of social interaction while eating may also contribute to creating a poor impression of what is on offer, no matter how good the food being served actually is.

In this review, I start by examining the effects that low cabin air pressure, the lack of humidity in the air, and the high levels of background noise have been shown to have on people's ability to taste and smell food and drink. I then move on to take a brief look at a number of other factors that are not typically mentioned, but which research on the ground suggests might impact a passenger's food and beverage experience while up in the air. I also highlight an important distinction between the short-term, marketing-led, innovations in food service provision in the air (that one often reads about in the press), and the longer-term fixes that will be needed if we are to improve the quality of the passenger's multisensory experience in the long-run.

Peer review under responsibility of AZTI-Tecnalia.

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[1] Or as one journalist put it: *"The inexplicable blandness of airline food has been pondered at 30,000 feet by generations of travellers."* (Connor, 2010).

[2] Of course, the long-term service contracts that many of the airlines have signed-up to tend to stifle even the most creative chef's culinary innovation at altitude (see Jones, 2004, 2007; Spence, 2017).

http://dx.doi.org/10.1016/j.ijgfs.2017.05.001
Received 18 April 2017; Accepted 11 May 2017
Available online 12 May 2017
1878-450X/

Atmospheric factors deleteriously affecting tasting at altitude

Lowered cabin air pressure

This will obviously affect olfaction (i.e., the sense of smell; Bert, 1878; Kuehn et al., 2008; Stepanek, 2002), but, perhaps surprisingly, it has also been reported to influence people's taste thresholds as well. To put the problem into perspective, once a plane reaches cruising altitude, it has been suggested that the air pressure in the cabin will normally be equivalent to what one finds at c. 6000–8000 ft above sea-level (Beck, 2014). Research conducted in a pressure-controlled chamber, where taste thresholds were assessed in the same six female participants at the equivalent of sea level, and then again at altitudes of 5000 and 10,000 ft (with the order of conditions counter-balanced), documented significant changes at higher altitudes (see Maga and Lorenz, 1972). Specifically, the thresholds for detecting the presence of a tastant in solution increased from sea-level to 5000 ft.[3] However, a more careful look at Maga and Lorenz's data reveals that this effect was driven solely by a dramatic change in the threshold for bitterness – that is, thresholds for sweetness, saltiness, and sourness were unaffected by the changes in air pressure. Their results showed that participants were able to detect the bitter solutions as a much lower molar concentration at sea-level than when tasting at a pressure equivalent to 5000 ft or more.

Meanwhile, a study commissioned by Lufthansa from the Fraunhofer Institute in Germany showed that salt and sweet are most adversely affected by cabin conditions. In particular, Burdack-Freitag et al. (2011) conducted a series of carefully controlled psychophysical tests of taste and smell perception at normal and low atmospheric pressure in a simulated aircraft cabin (i.e., conducted in a 16 m section of an airplane on the ground). The high-tech. set-up allows researchers to simulate not only air pressure and humidity, but also ambient noise and vibration typical of flight. The participants who took part in this study were given a series of solutions to taste. The results revealed that both taste and smell perception were suppressed under the low pressure conditions that are typical of flight. These results have been taken to support the claim that food loses 30% of its taste when sampled in the skies. Sweetness and saltiness seem to be especially badly affected (salt being rated as 20–30% less intense while sugar was rated as 15–20% less intense under simulated high altitude conditions). Sour, bitter, and spicy tastes, meanwhile, remained more or less unaffected (Michaels, 2010).[4]

Dry cabin air

The lack of humidity in the frequently-recycled air is also an important factor. It has been estimated that the air is recycled every 2–3 min (Beck, 2014), and that the humidity at 35,000 feet is something like 12%, much lower than one finds on the ground (equivalent to what one might find in the desert; Moskvitch, 2015; by comparison, humidity in the home tends to exceed 30%, see http://www.who.int/ith/mode_of_travel/chad/en/). Reduced levels of ambient humidity have been shown to impact the perception of aroma (e.g., Kuehn et al., 2008; though see also Philpott et al. (2004)), and hence flavour perception.

Noise

According to Ozcan and Nemlioglu (2006), the noise from the engines on commercial flights is somewhere in the range of 80–85 dB(A). The exact figure depends on where you sit relative to the plane's engines, and on the type of aircraft you find yourself flying in. A number of studies have demonstrated that loud background noise deleteriously affects taste perception (Woods et al., 2011; Yan and Dando, 2015). However, it is worth noting that loud background noise has also been shown to impair olfactory perception (Seo et al., 2011, 2012). Meanwhile, noisy ambient conditions can impair people's ability to discriminate the alcohol content in drinks served on the ground as well (Stafford et al., 2013, 2012).

Yan and Dando (2015) conducted one of the most relevant studies on the impact of aircraft noise on taste thresholds. These North American researchers tested a group of participants (N=48) in the laboratory. The latter had to rate the intensity of a range of solutions containing one of the five basic tastes at one of a range of concentrations using a Labeled Magnitude Scale. The results revealed that perception of sweetness was suppressed when the participants were exposed to 85 dB of airplane noise, while the taste of umami was rated as more intense instead.[5] According to Prof. Dando: *"Interestingly, sweet taste intensity was rated progressively lower, whereas the perception of umami taste was augmented during the experimental sound condition, to a progressively greater degree with increasing concentration."* (quoted in Griffiths (2015)).

While we do not yet have a good account for why background noise should exert a differential effect on the various basic tastes, the point remains that such a pattern of results cannot simply be accounted for in terms of distraction (Connor, 2010), as that would be expected to affect all tastes equally.[6] Intriguingly, though, Yan and Dando's findings may help to explain one of the enduring mysteries about food and beverage consumption in the skies: Namely, why it is that so many people drink tomato juice or else order a Bloody Mary while up in the air (see Guilhem (2014), Jackson (2014) and Spence et al. (2014)).[7] Indeed, according to one German survey of 1000 passengers conducted a few years ago, roughly one in four of us order a tomato-based drink from the flight attendants (Burdack-Freitag et al., 2011). Intriguingly, 23% of passengers reported that they *never* drink tomato juice while on the ground.[8] Given that both tomato juice (and the Worcester Sauce added to make a Bloody Mary) are umami-rich, it is almost as if passengers might be self-medicating at altitude by choosing to order a drink that should stand up well to the extreme atmospheric conditions found at altitude. Reports suggest that tomato juice tastes less earthy, more acidic, and the survey results would suggest more appealing, in the air.

Using gastrophysics findings to enhance the taste of airline food and drink

There are a number of suggestions/recommendations that flow naturally from each of these identified limitations for anyone wanting to enhance the passengers' experience of food and drink in the air:

[3] Taste thresholds in Maga and Lorenz's (1972) study did not change as the simulated altitude changed from 5000 to 10,000ft.

[4] The extra sugar that needs to be added to airline food to make up for this loss of taste may help to explain why it is that people consume more than 3400cal between their check-in at the airport and their arrival at their destination. This according to Dr. Charles Platkin, who does an annual calorie count of the food offered by the big airlines, the average number of calories per item in the air was 360 in 2012; Calorie estimate from a survey conducted by Jetcost.co.uk; See *The Sunday Times (Travel)*, **March 15**th, 3. However, passenger stress may also play a role here (Sproesser et al., 2014).

[5] Meanwhile, thresholds for bitter, salty, and sour were unaffected by the presence of realistic levels of airplane noise. Note here that Woods et al. (2011) reported that both sweetness and saltiness are suppressed by loud white noise.

[6] See Ferber and Cabanac (1987), for one evolutionary suggestion regarding the impact of stressful loud noise on our responses to sweet and salty tastes.

[7] So, for example, Jackson (2014) notes that: *"A few years ago, the German airline Lufthansa realized they served about 53,000 gallons of tomato juice annually. That's just shy of the 59,000 gallons of beer they serve each year. Which is really significant, says Lufthansa catering executive Ernst Derenthal."*

[8] Of course, the mystery remains as to why certain tastes are affected and not others. Furthermore, one might also wonder why it is that sales of tomato juice and Bloody Mary haven't gone through the roof on the ground too, given how many restaurants and bars now clock-up a higher decibel count than that typically experienced on the plane (McLaughlin, 2010; Sietsema, 2008a, 2008b; see Spence (2014), for a review).