How To Eat Garlic Without Causing Bad Breath

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ABSTRACT

We study taste reproduction using taste sensors, with a particular emphasis on accurately measuring and reproducing the taste of garlic while reducing the associated bad breath. We measured and reproduced the taste of garlic using a combination of odorless substances. We also developed a fork integrated with a mechanism for releasing the aroma of allicin to provide controlled exposure to the nose for a complete eating experience. Through our experiments, we successfully achieved identical taste and smell experiences, effectively eliminating the occurrence of bad breath. To validate our findings, participants tasted a dish of spaghetti and reported that the culinary experience was very similar to that of normal garlic-infused dishes, with no detectable bad breath.

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI); Interaction devices.**;

KEYWORDS

Virtual eating experience, Taste reproduction, Taste sensor, Flavor mixing, Taste the TV, TTTV2

ACM Reference Format:
Miku Fukaike and Homei Miyashita. 2023. How To Eat Garlic Without Causing Bad Breath. In *The 36th Annual ACM Symposium on User Interface Software and Technology (UIST '23 Adjunct), October 29–November 01, 2023, San Francisco, CA, USA.* ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3586182.3616659

1 TASTE REPRODUCTION USING TASTE SENSOR AND TASTE DISPLAY

Thus far, our research has focused on the reproduction of taste using taste sensors and taste displays [1] [2]. For example, we measured the taste of Japanese crab cream croquettes, which taste similar to crab cake, and milk, and reproduced their taste by combining substances such as sodium chloride, sucrose, and potassium carbonate to compensate for the difference in taste [3]. We also wanted to distinguish between poisonous and edible mushrooms by assessing the taste of two specific species: fly agaric (Amanita muscaria), a poisonous mushroom, and king trumpet mushroom (Pleurotus eryngii), an edible species. We successfully replicated their distinct tastes by spraying appropriate flavorants that highlighted their differences [4]. In addition, certain nonalcoholic beers are made to taste like regular beer by skillfully blending various ingredients without wheat [5]. These approaches effectively address the disadvantages associated with the original foods, which may be harmful to individuals with shellfish allergies or pose other risks, such as the consumption of poisonous mushrooms or excessive alcohol intake. In this study, we measured and reproduced the taste of garlic to allow eating it without causing bad breath. In terms of etiquette, this can provide relief so people do not feel uncomfortable after eating.

2 CONSIDERATION FROM THE MECHANISM OF HALITOSIS AFTER EATING GARLIC

This section presents the mechanisms underlying bad breath after eating garlic. First, it is important to note that the smell of garlic and bad breath stem from different substances. The smell of garlic can be attributed to allicin, while bad breath is caused by allyl methyl sulfide. When garlic cells are broken, alliin and the alliinase come into contact, resulting in the production of allicin, a pleasant-smelling compound found in garlic dishes [6].

However, upon chewing and swallowing, larger quantities of allicin are generated, which are subsequently converted into significant amounts of allyl methyl sulfide during digestion in the stomach. This compound causes bad breath by emitting an extremely unpleasant odor [6]. Moreover, it circulates throughout the body via the bloodstream, causing both bad breath and body odor. Notably, its concentration in the oral cavity and lungs for up to three hours following consumption, surpassing that of other sulfur-containing gases. Furthermore, even while brushing teeth, approximately half of the allyl methyl sulfide persists and proves challenging to eliminate [7]. Conversely, unless large amounts of allicin are digested in the stomach, allyl methyl sulfide is not produced, thereby averting the occurrence of bad breath.

In fact, we crushed and heated garlic and left one in saliva and one in 10% dilute hydrochloric acid, a concentration similar to stomach acid, for two hours. The former had a pleasant garlic aroma, but the latter emitted an unpleasant smell. Therefore, it can be inferred that inhaling the scent of garlic does not result in bad breath or body odor.

By investigating the underlying factors of garlic-induced bad breath, this study yielded a potential solution. By ensuring that large amounts of allicin do not reach the digestive organs, bad breath can be prevented. We measured the taste of garlic using a taste sensor and reproduced the same taste without the use of allicin. Because the substance used to reproduce the taste is naturally colorless, odorless and transparent tasting substance and devoid of allicin, we propose that the taste experience of garlic can be reproduced in a completely odorless manner. However, given that the aroma of garlic is widely acknowledged as a crucial aspect of the food experience, we posit that the olfactory experience can also be reproduced by delivering the minimum amount of allicin to the

UIST '23 Adjunct, October 29–November 01, 2023, San Francisco, CA, USA

ACM ISBN 979-8-4007-0096-5/23/10.
https://doi.org/10.1145/3586182.3616659

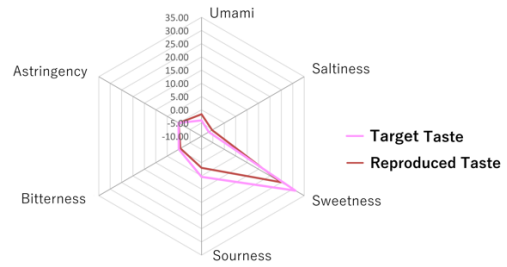

Figure 1: Comparison between target taste and reproduced taste using the TS-5000Z Taste Sensor.

nose. We developed a device wherein allicin is released from the handle of a fork rather than from the tip, thereby avoiding any potential contamination of the food.

3 REPRODUCTION OF GARLIC TASTE

Building upon the insights shared in the previous section, we first attempted to reproduce the same taste of garlic using an odorless substance and a taste sensor. The target taste for reproduction was obtained by mixing 80 g of olive oil, 20 g of fresh garlic, 0.6 g of salt, and 100.6 g of water and heating in a microwave oven at 600 watts for 1 minute. The recipe for reproducing the taste of garlic is as follows: 10 g of water, 8.0 g of fructose (sweetness), 8.0 g of monosodium glutamate (umami), 1.0 g of sodium chloride (saltiness), 0.40 g of lactic acid (sourness), 0.24 g of arginine(bitterness), and 0.040 g of N-vanillylnonanamide (spiciness). The comparison results of these tastes are shown in Figure 1. Each sample was diluted 200 times and measured using a TS-5000Z Taste Sensor [8]. The user can make their own mix based on this recipe or use the TTTV mentioned above [1] [2]. Mixed according to this recipe, it can be used in a variety of ways, such as spaghetti aglio e olio or garlic toast. Even if garlic were to disappear from the world, we would still be able to taste garlic using this technique.

4 FORK DEVICE WITH TASTE AND AROMA OUTPUT

We have developed a specialized fork featuring a built-in mechanism designed to release the aroma of allicin. This design ensures that only the minimum required amount reaches the nose, enhancing the overall culinary experience. The case was 3D printed and an allicin aroma cartridge was attached to the dishes and the smell output was controlled by M5StickC Plus.

When the fork is inserted into the mouth and the switch on the handle is activated, a DC fan (Nidec F16EA-03LLC) is activated, facilitating the delivery and release of the allicin aroma through a hole at the base of the handle (Figure 2). This innovative design allows users to simultaneously taste and smell the essence of garlic as they bring the fork to their mouth, giving them the experience of consuming an authentic garlic-infused dish.

5 EVALUATION AND FUTURE WORK

In our research, we successfully delivered an identical taste and olfactory experience while eliminating the issue of bad breath. To validate our findings, we conducted a test involving 20 subjects, who were asked to eat spaghetti boiled in salt using the developed fork. They were then queried whether the experience closely resembled that of eating spaghetti aglio e olio. Unanimously, all participants reported a striking similarity. After another 3 hours, the subjects were asked to report whether they experienced bad breath, and none of them reported bad breath.

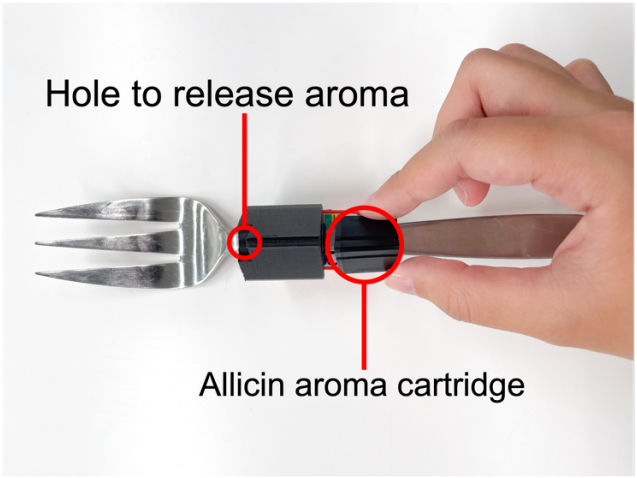

Figure 2: Fabricated fork used in this study.

In our future work, we intend to use a sensor capable of accurately measuring odor to quantitatively evaluate post-meal breath odor using our proposed method. We are also considering the possibility of automating the timing of aroma presentation by attaching a sensor. Furthermore, we aim to extend the applications of this method beyond garlic and explore its efficacy in reproducing the taste of various other foods with a distinctive post-meal aroma.

6 RELATED WORKS

Several studies have proposed the use of olfactory displays. Judith et al. developed a necklace-type olfactory display [9], which allows the manual control of a single aroma to emit subtle scents. Moreover, Narumi et al. demonstrated that taste perception can be altered by presenting olfactory information using an air-pumped olfactory display and visual information via augmented reality technology (i.e., AR) [10]. Furthermore, Matsukura et al. proposed an olfactory display that can create the illusion of an odor originating from a specific location by manipulating scented air streams [11]. Lin et al. proposed an eating experience that overlays olfactory presentation using a fork-shaped device with an aroma box and color information using AR to make the user feel as if they are eating a different food with a similar texture [12].

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