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RESEARCH ARTICLE

TASTE MAPPING: A NEW APPROACH FOR THE TASTE REGIONS

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ABSTRACT

Gustation is a chemical sense acting as an ultimate checkpoint for accepting a nutrient food or debunking a recognized toxic substance. Our gustatory system is a necessity for food detection as well for human survival. Our tongue is a muscular organ serving as a repertoire for the well-known theoretical diagram being taught at schools stating that our tongue is divided into sections: Bitter on the back, sour and salty bilaterally, sweet on the tip and umami in the middle. However, scientists at Columbia University studied 8,000 taste buds scattered on the tongue and reported that it is down to cells in the brain, not in the tongue, to work out which taste is which (O'callaghan J. 2014).Why are there parts of the tongue better at detecting some particular tastes? According to our survey, sweet and salty tastes were highly detected though it was the opposite for umami. Respectively, the interpretation of food targets the nerve like taste cells located on apical epithelial specialized taste buds. Those nerve signals reach the VPM in the thalamus, then, to be carried to the sensory cortices in the brain. Accumulated evidence proposed fatty acid as a new taste that has candidate receptors. In this prospective study, taste mapping was revealed experimentally that it does not exist. Statistically, we measured the percentage of tasty on the five specified regions (%) and its correlation with gender and smoking. Most evidence revealed fatty acid to be albeit with no taste quality at low concentration and unpleasant at a supra-threshold concentration by altering the texture. Free fatty acids differ in saturation and length suggesting the presence of complex mechanisms which do rely over more than one receptor. This could be a supporting step for the association between the oral exposure to fatty acid and obesity due to the minimized taste cues.

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INTRODUCTION

Perception of taste, smell and texture influence dietary behavior, shape an individual's food preferences and affect his long term health. Mouth is the first digestive organ owning the tongue which is well supplied with blood and primary nerves. By dripping a stimulus, taste signals are transmitted to the brain stem from either the glossopharyngeal nerve (cranial nerve IX) in the back, the facial nerve chorda tympani (cranial nerve VII) or from the vague nerve (largest cranial nerve V) (Khan I. 2017). Afterwards, taste information is carried to the solitary tract and then to the cerebral cortex. Theoretically, tongue is sectioned off into different regions and each area refers to a particular taste (Munger S. 2015).

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Typically, ranges of 8 to 12 circumvallated papillae are arranged in a V-shape inverted manner towards the base of the tongue (du Toit DF. 2003). Taste sensitivity is the minimum intensity at which an individual perceives a specific taste. For instance, sweet solutions are hard to be detected at low concentrations. It has a high taste threshold compared to salt and other tastes. Although, bitter is the most sensitive taste that can even be sensed by its aroma way ahead from the gustatory system. Those who are insensitive orally are also insensitive in the gastrointestinal tract and over consume fatty food (Keast R. et *al.* 2015). There many primary qualities for discerning a certain taste. Upon hydrolysis of fats, triglyceride is released. Most evidence indicated that "triglyceride is not a taste stimulus, though it clearly contributes sensory properties to foods by carrying flavor compounds and altering texture" (Mattes RD. 2009). It is a warning signals that lipid metabolism is occurring.

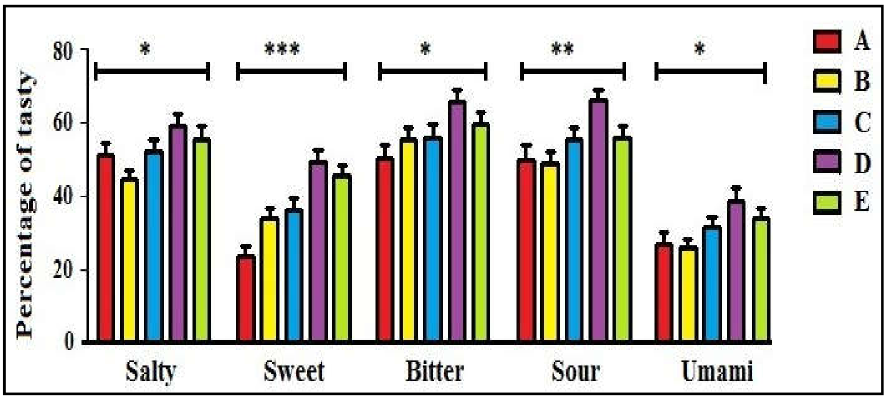

Figure 1. Means (±SEM) of the percentage of tasty. The percentage of tasty was measured (%) in participants (n=100) over the five different regions using the five known tastes Satistical analysis: One-way Anova Test: *$P < 0.05$; **$P < 0.01$.*$P < 0.0001$ were considered as significant**

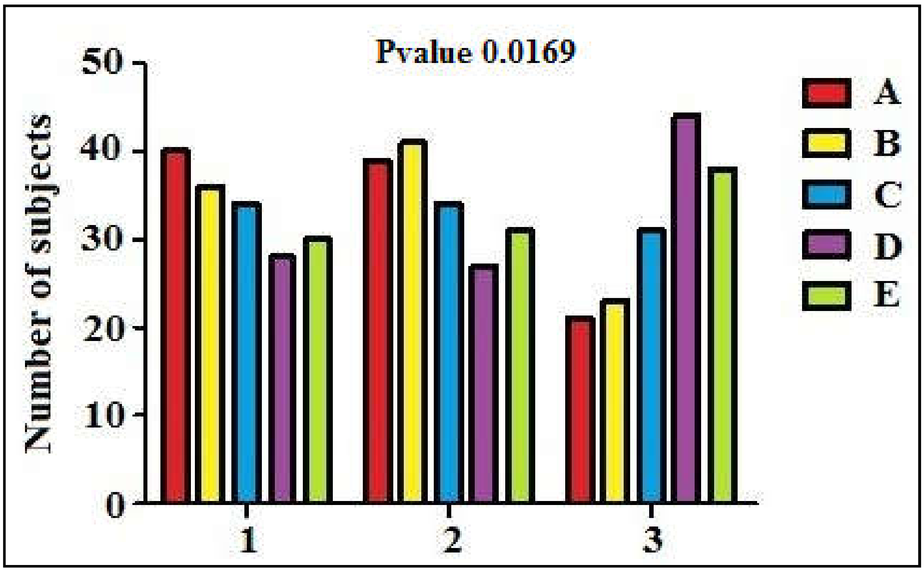

Figure 2. Region of tongue and grade tasty. The number of subjects was calculated as a function of the grade tasty (1 states for none or weak tasty, 2 for moderate and 3 for strong) Statistical analysis: Chi square test: : *$P < 0.05$ was considered as significant.

Its complex mechanisms are poorly characterized till the current while its implications go further into obesity field and health research domain. Borden G. (2008) stated that "Free fatty acids FFAs cause insulin resistance in all major insulin target organs (skeletal muscle, liver, endothelial cells) and have emerged as a major link between obesity".

MATERIALS AND METHODS

A prospective study was conducted over hundred participants (50 females and 50 males) between 18 and 75 years of age (Mean= 31.32 ± 12.86). The materials used in the experiment were: teaspoons and balance to measure the specific doses of every product related to a specific taste, table salt used to designate salty taste, sugar to designate sweet taste, olive oil to designate in a miniature way the new fatty acid taste. Equally, lemon in a liquid state was used to represent the sour taste, strong black coffee for the bitter taste and umami powder for the umami taste. Moreover, six plastic cups were used to be filled with the six simple products of the six different tastes. In order to insert some drops of a specific region of the tongue, cotton swabs served as an ultimate option. First, every participant's health status was acknowledged to make sure there is no suffer from any food allergy. Second, six cups were labeled with "salty", "sweet", "bitter", "sour", "umami" and "fatty acid". Third, all six solutions had the same principle by filling ¼ of the cup with water and adding two teaspoons of the product corresponding to the six distinct tastes. According to (www.convert-me.com), for the salty solution, two teaspoons were equivalent to 10 g of salt, for the sweet solution, two teaspoons were equal to 8 g of sugar. Then, for bitter solution, two teaspoons were equal to 3.53 g of black coffee. For Sour solution, two teaspoons from liquid lemon were added in the sour cup. Yet umami is in a solid powder state so a very minute amount was used. Lastly, "fatty acid" solution required two teaspoons of olive oil each with 5 ml. Fourth, a drop from each of the six cups was applied 5 times over the 5 theoretical regions starting by the back of the tongue, then on the sides from up and down, moving to the tip and ending up in the middle. Moreover, a statistical record was reported for every participant in whom six distinct tables were filled according to the strength and weakness of perceiving salt and the remaining ones.

Statistical analysis

The *Chi-Square* test (X^2 test) of independence was used to determine if there is a significant relationship between nominal (categorical) variables. One way annova was used to determine the significant difference of means between several groups. Normality of the data distribution was checked by the Kolmogorov-Smirnov test. Data are expressed as means ± SEM. A 95% confidence interval and a 5% level of significance were adopted; therefore, the results with a *P < 0.05; **P < 0.01.***P < 0.0001 (***) were considered significant. All statistics were calculated using graphPad prism software.

RESULTS

Considering the whole group examined in the study, significant differences were reported between the means of percentage of the five tastes on the five regions of the tongue (pvalue<0.0001). In regions A, C and D, salty, bitter and sour tastes had the same percentage of tasty. Furthermore, significant differences were found between the means of percentage of each taste in the 5 regions of tongue. There resides a significant association between region of tongue and grade tasty. A large number of subjects perceived strongly the tastes exerted on regions D and E. None of the participants were insensitive to a particular region of tongue. The majority of the participants tasted the five taste products with a moderate sensation (moderate = 172 as a total). Therefore, a clear link was demonstrated between the tastes and the receptors on taste cells over all areas of the tongue. There was no significant association between smoking and tasting sensitivity in females. The differences between the smokers and non-smoker ones were minor.

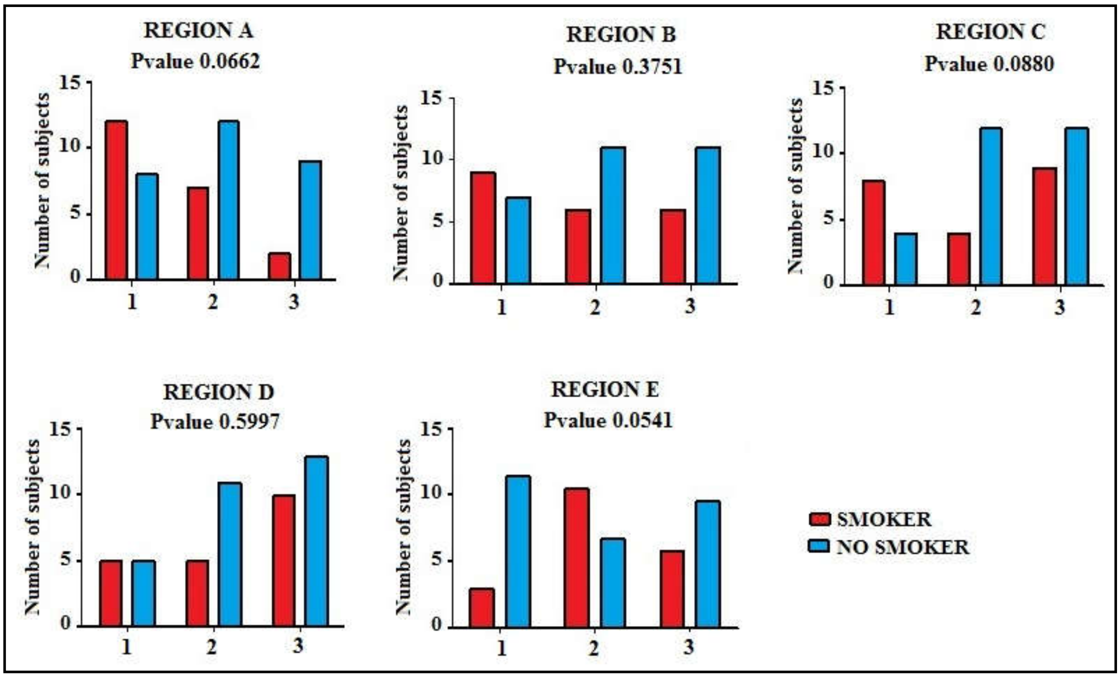

Figure 3. Smoking and grade of tasty in female. The number of subjects was calculated based on the smoker and non-smoker females' sensitivity to tastes on the five different regions of the tongue. Statistical analysis: Chi square test. : *P < 0.05; **P < 0.01.*P < 0.0001 were considered as significant.**

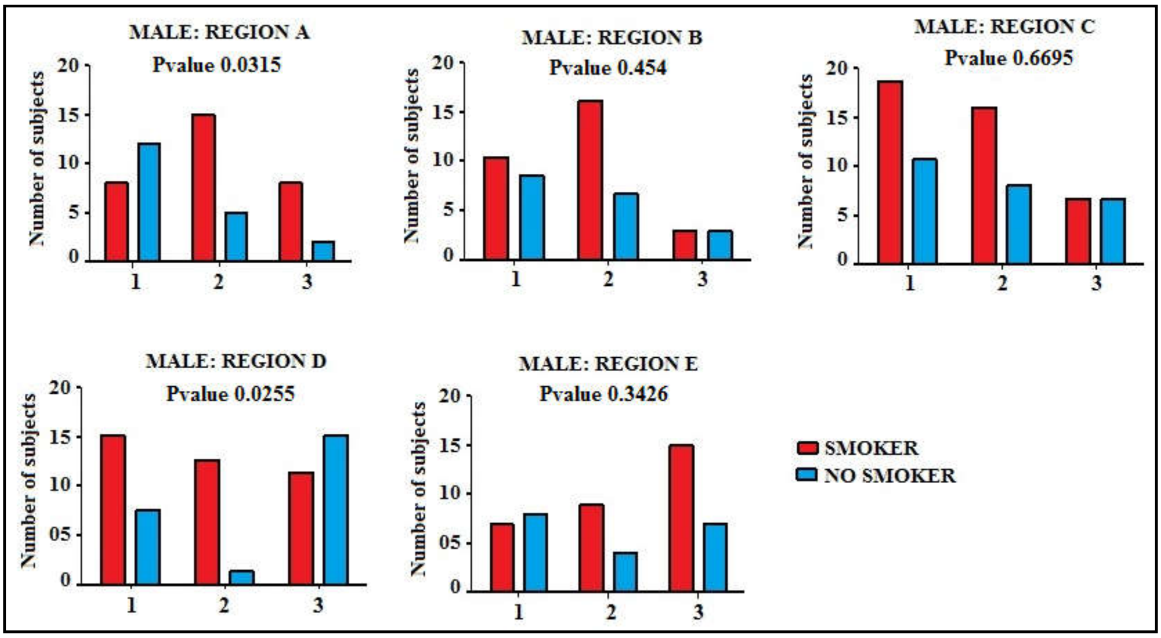

Figure 4. Smoking and grade of tasty in male. The number of subjects was calculated based on the smoker and non-smoker males' sensitivity to tastes on the five different regions of the tongue. Statistical analysis: Chi square test. : *P < 0.05; **P < 0.01.*P < 0.0001 were considered as significant.**

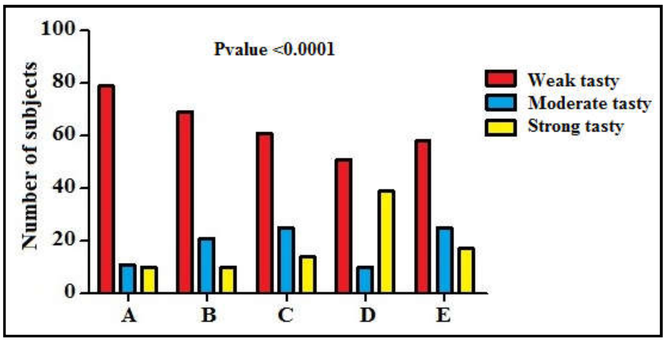

Figure 5. Fatty acid tasty. The intensity of detecting this new taste was measured over the five known regions from A to E. Statistical analysis: Chi square test. : ******P* < 0.0001 was considered as very significant

However, all non-smokers were known to sense much strongly than smokers. A subset of smoker's preferred higher sugar concentrations rated as a preference. Such preference was affected by nicotine dosage. A significant association lied between smoking and grade of tasty in the regions A and D in males. Although nicotine reduces the intake of food, yet it has here a selective effect on sweet-tasting foods. Although there was a very strong association between grade tasty and regions of tongue, fatty acid taste was poorly detected. Since free fatty acids differ in length and saturation, complex non specific mechanisms were present. FFA was not a taste specific.

DISCUSSION

The outcome obtained in this study further supports the rejection for the tasting map hypothesis. "As reported in the journal Nature this month, scientists have identified a protein that detects sour taste on the tongue." (Wanjek C. 2006, Lindemann B. 2002). It is unlikely to figure out one spot that detects a certain taste over another. Although, this study seems to be comparable with the idea of sensitivity of some regions at detecting some tastes at a higher rate. For instance, black coffee was detected everywhere in the mouth but it was sensed strongly in region A at the back. Many participants had 100% for bitter taste in all regions of the tongue. Taste buds are not replaced as fast in elderly people than in young ones. In this study, lack of a control group limits the interpretation of our results. The current study only examined the grade tasty denying the threshold at which the taste can be sensed.

Conclusion

Tongue sensitivity is not the same for everybody. It depends on the number of taste receptors a person has and the number of taste buds in his/her tongue. Parameters likeage, gender, smoking and health also contribute to one's individual sensation. Special receptors on taste buds match with neurons in the brain, each attuned to a certain gustation. Since triglyceride is not a specific taste stimulus, fatty acid taste does not have the primary basic taste qualities. FFA should undergo further investigation. To date, upon exposure to any taste, signals are generated resulting in an array of physiological responses which are well characterized. Five tastes were identified theoretically whereby not each is responsible for a particular region once the entire tongue can sense all. Understanding fatty acid taste and its correlation with the minimized ability to taste FFA resulting in obesity is a necessity. This over-consumption provides the basis for new approaches to control obesity.

Conflit of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper. All the contents of this article including results and discussion, conclusion, figures and tables are based on the original research work of the author.

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