

The Aftertaste of Bad Science: Stances towards MSG of Reddit Users

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ABSTRACT

Monosodium glutamate (MSG) is a cooking salt widely used in processed foods, seasoning mixes, and Asian restaurants. Despite its frequent occurrence and the fact that recent research shows that it is generally safe, recent surveys find that it remains stigmatized in the eyes of the public. In this research, I annotate data from the online discussion platform Reddit to investigate Reddit users' stance towards MSG. I find that Reddit users generally have positive views on MSG. Additionally, the results suggest that the MSG perceptions on Reddit have improved over time. Positive Reddit users often mention the research that indicates MSG is safe, it's widespread usage, and it's taste. Negative Reddit users often mention anecdotal evidence.

1 INTRODUCTION

Monosodium glutamate (MSG) is a cooking salt that imparts umami taste to dishes. MSG is commonly used in Asian (particularly Chinese) cuisines, as well as in many processed foods and seasoning mixes. Despite its common occurrence in processed foods, MSG remains controversial in the eyes of the public [24].

MSG has a rich history as an ingredient, as described by J. Sand [20]¹. The controversy around MSG began in April 1968, when a letter from Dr. Robert Ho Man Kwok was published in the New England Journal of Medicine, describing that he suffered various adverse symptoms whenever he ate at a Chinese restaurant [11]. The article was titled "Chinese Restaurant Syndrome". Among other ingredients, Dr. Kwok mentioned MSG as being one of the possible causes of his symptoms.

Scientific research on MSG quickly followed this letter. Early animal research found relations between MSG and adverse health effects: mice treated with MSG suffered brain lesions and obesity [14]. Following such early research, MSG became a stigmatized ingredient.

However, early animal research concerning MSG was later criticized for their very weak research methods [5]. Since then, a bulk of research has investigated the effects of MSG consumption on health. Recent reviews of the available research have failed to find a substantive connection between moderate MSG consumption and health effects [1, 10, 27].

The availability of this new research might cause a reversal in the perception of MSG. Various news articles state that MSG is improving in reputation [2, 15, 22]. The senior director of public

relations for the North-American branch of Ajinomoto, a corporation that produces MSG, believes that members of the younger generations have more positive views on MSG [15].

Considering the public opinion on MSG is important for its usage in products and dishes. MSG itself has promising uses: it could be used to lower salt levels in food without compromising flavor [7] and it simply makes food taste better. However, if the addition of MSG would discourage the public from buying such products, then the addition is senseless. For this reason, understanding public opinion on MSG is important.

In this research, I will investigate the stances of Reddit, an online discussion platform, users on MSG. Researching a discussion platform like Reddit is interesting, as, in discussions, people often mention why they hold a certain belief. This allows investigating the reasons behind the stances of users. Additionally, large amounts of Reddit data are freely available and can be gathered from different periods. With this Reddit data, I will investigate three things:

- (1) What is the stance of Reddit users towards MSG? Although existing research has shown a generally negative public perception of MSG [24], there is evidence that the younger generations have more positive views on MSG [15, 24]. As the Reddit demographic is highly skewed to a young demographic [21], I hypothesize that Reddit users are generally positive.
- (2) Have the stances of Reddit users become more positive over time? As some news articles claim that MSG is improving in reputation [2, 15, 22], I hypothesize that the users in a recent period are more positive than users in an earlier period.
- (3) What are the common themes in discussions surrounding MSG? Recent research found that fear towards (unnatural) chemicals in food was impactful on MSG perception [24]. I will explore the themes users bring up when discussing MSG.

To measure stance, I will, with the help of fellow annotators, annotate users as having either positive, neutral, or negative stance. Reddit comments also have a score, which results from the votes of fellow users. This score will also be considered in the analysis.

2 RELATED WORK

Public Perception on MSG. Most research on the public perception of MSG studied this using surveys. A research survey by Wang and Adhikari [24] found that the U.S. public generally has negative views on MSG. However, the study also found that Millennials perceived MSG statistically significantly as more beneficial than other generations. Additionally, fear of chemicals in food (chemophobia) was a significant predictor for less positive views on MSG.

Other research found that the Malaysian public was more positive and willing to pay more, for products with 'no MSG' labels

¹I fully encourage people to read the article by J. Sand if they are interested in the topic. The interplay between cultural trends and the public perception of an ingredient is fascinating.

[17]. Prescott and Young found that the public in New Zealand also had generally negative views of MSG, but that this did not decrease their enjoyment of foods of which they knew contained MSG [16]. Wang, Zhang, and Adhikari obtained the same results [25].

Text-Mining Reddit for Public Perception. Various studies have used Reddit to gauge public perception, for instance on JUUL electronic cigarettes [3], the H1N1 vaccine [9], China [8], and the HPV vaccine [12]. However, I could find no research that investigates Reddit for public perceptions of ingredients.

A nearly-complete Reddit dataset has been compiled by Jason Baumgartner under the username `\u\Stuck_In_the_Matrix` [23]. Although it is commonly used by researchers, Adams et al. found that there are gaps in this dataset [6]. They found that missing data disproportionately affected certain periods and Subreddits (i.e. subforums). They report that overall, 0.043% of Reddit comments are missing from the dataset.

3 METHODS

Data Collection. To extract the data, I used the dataset provided by user `Stuck_In_the_Matrix` [23]. As Adams et al. investigated, there are gaps in this dataset [6]. However, they identify that the risk of these gaps is only high or medium when the research concerns user history analysis, network analysis, or event-frequency counting. Since my methods do not fall within these methods, I consider the effects of gaps to be low-risk.

There are several different cooking and nutrition-related Subreddits. I selected the ones that are relatively big and discussion-focused (in contrast to image-focused). Ultimately, I selected `/r/Cooking`, `/r/recipes`, and `/r/nutrition`.

I collect data from two periods: a recent period (the first four months of 2019) and an earlier period (2008 to 2012). I selected these two periods based on two considerations: (1) The temporal difference between these two periods should be as large as possible as any effect of a linear trend over time would then be the more apparent; (2) however, as Reddit has become more popular over time, the early period had to be longer than recent period to obtain about equal quantities of data.

Among the comments in the selected Subreddits and periods, I used a keyword-based selection. If a comment contained the term 'MSG', or one of its synonyms or brand names, it was selected. The keyword selector did not consider capitalization.

Ultimately, I obtained 713 comments from the early period and 677 comments from the recent period. I also extracted information about the author, Subreddit, score, time, along with the comment.

Preprocessing. Several preprocessing steps were applied to the data. First, I excluded spam comments and comments made by bots or with deleted accounts. I consequently inspected the different data attributes for anomalies. Finally, I aggregated the comments by user.

Most of the data attributes did not seem anomalous, apart from the date distribution of the earlier period, displayed in figure 1, has a single large spike. It turns out that most of the comments in this month came from the single Reddit thread, where the comments are generally positive about MSG. The effect of this is further discussed

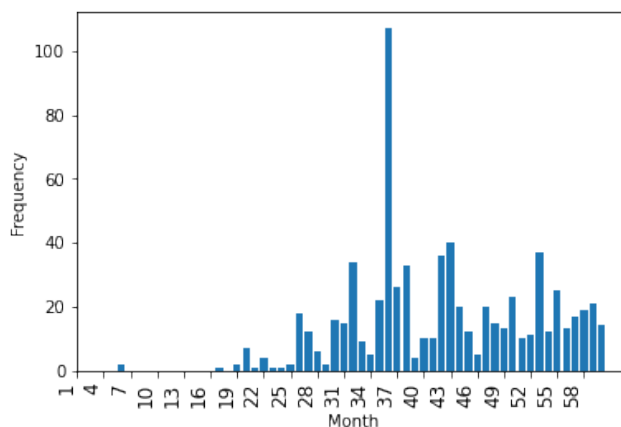


Figure 1: Frequency of Comments Mentioning MSG per Month in 2008-2012.

in the discussion section. The comments in the recent period are mostly evenly distributed.

Annotation. The aim of annotation was to assign each user a positive, neutral/ambiguous, or negative label. Interpreting the stance of users through Reddit comments is inherently difficult: users usually do not explicitly express their views. Furthermore, the comments exist within the larger context of a Reddit thread, which means relevant information might be missing. This ambiguity introduces a high degree of subjectivity in the process. I asked other annotators to help, to lower and measure the degree of subjectivity.

I send the aggregated (by user) comments to two fellow annotators alongside annotation instructions and instructed them to start at different indices. After they were finished, I annotated the same users as they had. In the case of ties, I either set the annotation to neutral (in a tie between negative and positive) or had the remaining annotator resolve the tie.

The annotation instruction explained the aim of the research, a short history of MSG, and guidelines for how to perform the annotation. For each annotation label, typical examples of users were given. As there is a high amount of ambiguity in interpreting Reddit comments, I instructed the annotators to 'fill in the blanks', i.e. assign the most likely label, even if the stance is not explicitly expressed. As an example, a user that suggests a recipe including MSG does not explicitly express their stance on MSG, but should still be labeled positively. I followed this guideline too.

4 RESULTS

After the annotation process, 396 users were annotated: of those, 203 in the recent period, and 193 in the earlier period. No users appeared in both periods. To simplify terminology, I will denote positively labeled Reddit users as 'positive users', and negatively labeled Reddit users as 'negative users'.

Assigned Labels. As is visible in figure 2, the assigned labels lean towards the positive side. For both periods, more positive labels always have a higher percentage than less positive labels.

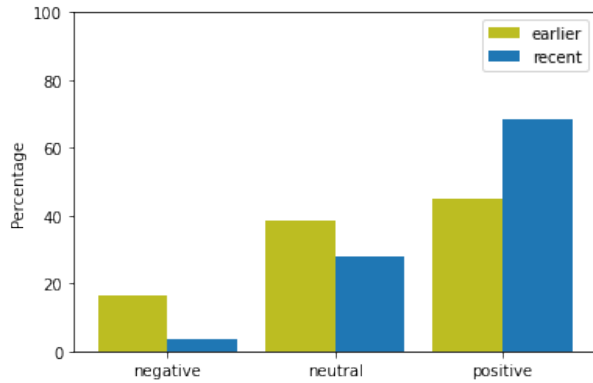


Figure 2: Percentage of Annotated Label for both Periods

This effect seems stronger for the recent period than the earlier one. There are proportionally more than four times as many negative users in the earlier period than the recent period (16.6% to 3.4%). There is an about 23% percentual difference in positive users between the earlier and than the recent period (45.1% to 68.5%).

A non-parametric Mann-Whitney U test indicates that both conditions (earlier vs recent) have significantly different distributions ($U=14353.5$, $p<0.001$). However, as the distribution shapes differ, a directional difference can't be inferred from this test.

User Scores. Each user's score was calculated as the mean score of their comments. Figure 3 show the median user scores for different periods and labels. The median was chosen instead of the mean as a metric for the central tendency as the distribution of user scores is highly skewed.

As figure 3 displays, in both periods, the more positive labels seem to obtain higher scores. Curiously, this effect seems to be gradual for the earlier period, and abrupt (between negative and neutral) for the recent period. The Spearman's rank correlation between stance and user score for both the earlier period ($\rho(193)=0.33$, $p<0.001$) and the recent period ($\rho(203)=0.24$, $p<0.001$) were significant.

Out of the ten highest-scoring users (from both periods), nine of the ten were positive. The labels of the least-scoring users were much more mixed: three were negative, five were neutral, and two were positive.

Themes. For exploring the themes, I investigated the users' comments for different combinations of positive/negative users, earlier/recent period, and sorted by highest/lowest score. Prevalent themes were:

- (1) Anecdotal Evidence of Adverse Health Effects. In both periods, negative users often report adverse health effects when consuming MSG. Especially in the recent period, these users often had a negative score. Likewise, positively labeled users often contested that negative health effects could be attributed to MSG consumption.

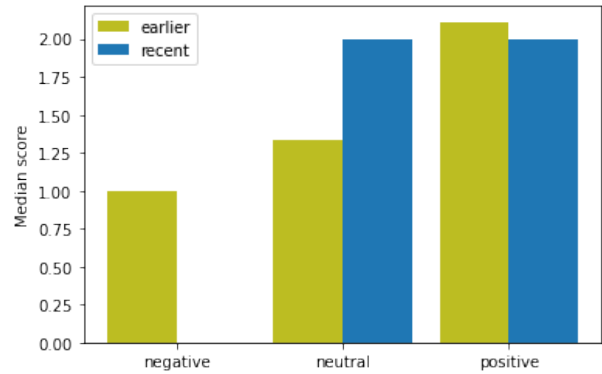


Figure 3: Median Score for each Annotated Label and Period

- (2) Research on MSG. In both periods, positive users often mention the research showing that MSG is generally safe. Users mentioning this usually had a high score.
- (3) Presence of MSG in Foods. In both periods, positive users often mentioned that MSG is present in many processed, or even natural, foods. Users mentioning this usually had a high score. Some users also mention using MSG in their foods, and that family members who claimed to be MSG-sensitive, do not notice.
- (4) Taste of MSG. Especially in the recent period, many highly voted, positive users mention that MSG tastes good.

Validation: Inter-Annotator Agreement. To measure the degree of subjectivity in the labels, I computed Cohen's Kappa between my annotations and those of the other two annotators. The Cohen's Kappa with the first annotator was 0.64, with the second 0.29, and overall it was 0.48. For comparison, Cohen originally indicated a Kappa of 0.2 to 0.4 as fair agreement, 0.4 to 0.6 as moderate, and 0.6 to 0.8 as substantial [4].

The difference of 0.35 in Cohen's Kappa of my agreement with the first and the second annotators is striking. The difference seems to result from a difference in the assignment of the neutral label: The first annotator and I assigned 30% of the users this label, but the second annotator assigned 68% of the users a neutral label. Inspection of the annotations of the second annotator showed that they did not sufficiently 'fill in the gaps': this annotator assigned neutral labels even if users suggested recipes with MSG, or implied that they use MSG. This goes against annotation instructions.

5 DISCUSSION

The main finding of this research is that Reddit users were generally very positive towards MSG. Previous research found a 'somewhat negative attitude towards MSG' [24]. With Reddit users, I find the opposite result. The stances of Reddit commenters lean towards a positive view of MSG. Likewise, for both periods, there was a significant correlation between a user's positivity on MSG and their score. One possible explanation for this finding, which is in line with existing evidence [15, 24], is that young people (toward which

Reddit's user base is skewed [21]) have generally more positive views on MSG.

I also investigated whether the stance of Reddit users has become more positive over time. There is some evidence that suggests so, but it is far from conclusive. In the recent period, there are proportionally more users with positive stances and fewer with negative stances. Statistical testing shows a significant difference between the label distributions in both periods, but due to data characteristics, a directional difference can't be inferred from this test. The correlation between stance positivity and user score was actually higher in the earlier period than in the recent period (0.33 against 0.24). However, the latter correlation might be heavily biased by the scarcity of negative users in that period (only 3.4%; 7 users).

On Reddit discussion, positive users emphasize the research indicating that MSG is generally safe, and it's widespread presence in food. Earlier research found that many people had a negative stance towards MSG based on chemophobia [24]. In an interesting twist, positive users do not dismiss chemophobia itself, but instead argue that MSG is not an unnatural chemical: they mention that MSG is naturally occurring in organic foods (such as tomatoes and cheese). In the more recent period, positive users often mention that MSG tastes good. This suggests that Reddit users are now more aware of the culinary properties of MSG.

Negative users often mention anecdotal evidence of symptoms after consuming MSG. However, such users are often assigned negative scores and argued against. This is troublesome, as although MSG is generally safe, there is evidence that MSG sensitivity in some people does exist [26]. The stigmatization of MSG should not be removed in favor of the stigmatization of individuals with MSG sensitivity.

There are certain limitations to this research:

- (1) **Subjectivity in Annotation.** Reddit comments are context-embedded and implicit with regards to stance, which makes them inherently difficult to interpret. This is reflected in the achieved Cohen's Kappa: 0.49, which is low. Unfortunately, one of the two additional annotators did not follow the annotation instructions. Ideally, they should have been disqualified and replaced, but I did not have the resources for this. With more annotators, more users could have been labeled, and with higher confidence.
- (2) **More Rigorous Analysis of Themes.** The analysis of the reasons given in this research was merely exploratory. The analysis was not validated in any way. To reach more rigorous conclusions, considering the themes or reasons of users should be incorporated in the annotation process. This also could reflect better the underlying perception of users: i.e. they can believe MSG is safe but that it does not taste well, which can not be represented with the current labels.
- (3) **Possibility of Bias in Selected Data.** As mentioned earlier, the dataset has gaps, but their effect is low-risk to this research. A more significant limitation is that many of the comments in the earlier period came from a single thread. As this thread was generally positive towards MSG, this

might have influenced the comments through 'herding effects' (users adopting the stance of the apparent majority) [13]. This could have introduced bias in the data.

- (4) **Meaning of Scores.** Ideally, comments score should represent whether a comment adds to the discussion [18]. In practice, however, voting is dominated by (dis)agreement. There is no academic source for this, but many Redditors agree [19]. In this research, I assumed the latter usage.

One explanation for the positivity towards MSG on Reddit is that younger people have more positive views on MSG. However, this research provides only indirect evidence for that explanation. Research that more directly considers the effect of age on MSG stance would be insightful.

This research focuses solely on the Reddit community, without the intent to generalize its findings to the general public. It is unclear how well the Reddit community represents the overall public. To reach broader conclusions, it would be interesting to consider communities that generalize better in future research.

6 CONCLUSIONS

In this research, I extracted comments made by Reddit users and annotated their stances. I found that, in contrast to the general public perception, Reddit users have a very positive stance towards MSG. Furthermore, there is some evidence that this positive stance is becoming more prevalent over time. Common themes for users that were positive towards MSG were the that the research indicates that MSG is safe, it's widespread usage, and it's taste. For negative users, anecdotal evidence was a common theme. For future research, it would be interesting to consider the effect of age on MSG stance, to consider online communities that generalize better to the general public, and to do a more rigorous analysis of the reasons behind MSG stance. The insights obtained by such research could inform food producers and chefs when they can spice up their dishes with MSG, without facing consumer backlash.

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REFERENCES

- [1] Tushar Bera, Kar Sk, Parmeshwar Yadav, Mukherjee P, Shankar Yadav, and Bishal Joshi. 2017. Effects of monosodium glutamate (MSG) on human health: a systematic review. *World Journal of Pharmaceutical Sciences* 5 (05 2017), 139–144.
- [2] Donna Berry. 2020. Is MSG making a comeback? *MeatPoultry* (Jan 2020). Retrieved November 25, 2020 from <https://www.meatpoultry.com/articles/22528-is-msg-making-a-comeback>
- [3] Emma I. Brett, Elise M. Stevens, Theodore L. Wagener, Eleanor L.S. Leavens, Taylor L. Morgan, Whitney D. Cotton, and Emily T. Hébert. 2019. A content analysis of JUUL discussions on social media: Using Reddit to understand patterns and perceptions of JUUL use. *Drug and Alcohol Dependence* 194 (Jan. 2019), 358–362. <https://doi.org/10.1016/j.drugalcdep.2018.10.014>
- [4] Jacob Cohen. 1960. A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement* 20,

- 1 (1960), 37–46. <https://doi.org/10.1177/001316446002000104> arXiv:<https://doi.org/10.1177/001316446002000104>
- [5] John D. Fernstrom. 2018. Monosodium Glutamate in the Diet Does Not Raise Brain Glutamate Concentrations or Disrupt Brain Functions. *Annals of Nutrition and Metabolism* 73, Suppl. 5 (2018), 43–52. <https://doi.org/10.1159/000494782>
- [6] Devin Gaffney and J. Nathan Matias. 2018. Caveat emptor, computational social science: Large-scale missing data in a widely-published Reddit corpus. *PLOS ONE* 13, 7 (07 2018), 1–13. <https://doi.org/10.1371/journal.pone.0200162>
- [7] Jeremia Halim, Ali Bouzari, Dan Felder, and Jean-Xavier Guinard. 2020. The Salt Flip : Sensory mitigation of salt (and sodium) reduction with monosodium glutamate (MSG) in “Better-for-You” foods. *Journal of Food Science* 85, 9 (Aug. 2020), 2902–2914. <https://doi.org/10.1111/1750-3841.15354>
- [8] Lan He, Ming Yin, and Yujia Shi. 2020. Love, Hate Thy Neighbour? Or Just Don't Care Much about Them: A Sentiment Analysis of China-Related Posts and Comments on Reddit.Com. *China Report* 56, 2 (2020), 204–220. <https://doi.org/10.1177/0009445520916874> arXiv:<https://doi.org/10.1177/0009445520916874>
- [9] Natalie Henrich and Bev Holmes. 2011. What the Public Was Saying about the H1N1 Vaccine: Perceptions and Issues Discussed in On-Line Comments during the 2009 H1N1 Pandemic. *PLOS ONE* 6, 4 (04 2011), 1–12. <https://doi.org/10.1371/journal.pone.0018479>
- [10] Zehra Kazmi, Iffat Fatima, Shaghuftha Perveen, and Saima Shakil Malik. 2017. Monosodium glutamate: Review on clinical reports. *International Journal of Food Properties* 20, sup2 (2017), 1807–1815. <https://doi.org/10.1080/10942912.2017.1295260> arXiv:<https://doi.org/10.1080/10942912.2017.1295260>
- [11] Robert Ho Man Kwok. 1968. Chinese-Restaurant Syndrome. *New England Journal of Medicine* 278, 14 (1968), 796–796. <https://doi.org/10.1056/nejm196804042781419>
- [12] Yuki Lama, Dian Hu, Amelia Jamison, Sandra Crouse Quinn, and David A Broniatowski. 2019. Characterizing Trends in Human Papillomavirus Vaccine Discourse on Reddit (2007-2015): An Observational Study. *JMIR Public Health Surveill* 5, 1 (27 Mar 2019), e12480. <https://doi.org/10.2196/12480>
- [13] Lev Muchnik, Sinan Aral, and Sean J. Taylor. 2013. Social Influence Bias: A Randomized Experiment. *Science* 341, 6146 (2013), 647–651. <https://doi.org/10.1126/science.1240466> arXiv:<https://doi.org/10.1126/science.1240466>
- [14] John W. Olney. 1969. Brain Lesions, Obesity, and Other Disturbances in Mice Treated with Monosodium Glutamate. *Science* 164, 3880 (May 1969), 719–721. <https://doi.org/10.1126/science.164.3880.719>
- [15] Megan Poiniski. 2020. From the blacklist to the spotlight: How MSG is staging a comeback. *Fooddive* (Apr 2020). Retrieved November 25, 2020 from <https://www.fooddive.com/news/from-the-blacklist-to-the-spotlight-how-msg-is-staging-a-comeback/576128/>
- [16] John Prescott and Ariane Young. 2002. Does information about MSG (monosodium glutamate) content influence consumer ratings of soups with and without added MSG? *Appetite* 39, 1 (Aug. 2002), 25–33. <https://doi.org/10.1006/appe.2002.0492>
- [17] Alias Radam, Mohd Yacob, Than Bee, and Jinap Selamat. 2010. Consumers' Perceptions, Attitudes and Willingness to Pay towards Food Products with “No Added Msg” Labeling. *International Journal of Marketing Studies* 2 (04 2010). <https://doi.org/10.5539/ijms.v2n1p65>
- [18] Reddiquette. 2020. Reddiquette. Retrieved January 13th, 2021 from <https://www.reddithelp.com/hc/en-us/articles/205926439>
- [19] Multiple Redditors. 2014. What Does it Really Mean to Up-vote/Downvote a Post? Reddit. Retrieved January 13th, 2021 from https://www.reddit.com/r/TheoryOfReddit/comments/1lpws2/what_does_it_really_mean_to_upvotedownvote_a_post/
- [20] Jordan Sand. 2005. A Short History of MSG: Good Science, Bad Science, and Taste Cultures. *Gastronomica* 5, 4 (2005), 38–49. <https://doi.org/10.1525/gfc.2005.5.4.38>
- [21] William Sattelberg. 2020. The Demographics of Reddit: Who Uses the Site? <https://social.techjunkie.com/demographics-reddit/>
- [22] NPR Staff. 2013. MSG, Seasoned For A Comeback. *NPR* (Nov 2013). Retrieved November 25, 2020 from <https://www.npr.org/sections/thesalt/2013/11/17/245728214/msg-seasoned-for-a-comeback>
- [23] User Stuck_In_the_Matrix. 2020. Full Reddit Submission Corpus now available (2006 thru August 2015). Reddit. Retrieved December 3, 2020 from https://np.reddit.com/r/datasets/comments/3mg812/full_reddit_submission_corpus_now_available_2006/
- [24] Shangci Wang and Koushik Adhikari. 2018. Consumer perceptions and other influencing factors about monosodium glutamate in the United States. *Journal of Sensory Studies* 33, 4 (July 2018), e12437. <https://doi.org/10.1111/joss.12437>
- [25] Shangci Wang, Shaokang Zhang, and Koushik Adhikari. 2019. Influence of Monosodium Glutamate and Its Substitutes on Sensory Characteristics and Consumer Perceptions of Chicken Soup. *Foods* 8, 2 (Feb. 2019), 71. <https://doi.org/10.3390/foods8020071>
- [26] William H. Yang, Michel A. Drouin, Margaret Herbert, Yang Mao, and Jacob Karsh. 1997. The monosodium glutamate symptom complex: Assessment in a double-blind, placebo-controlled, randomized study. *Journal of Allergy and Clinical Immunology* 99, 6, Part 1 (1997), 757–762. [https://doi.org/10.1016/S0091-6749\(97\)80008-5](https://doi.org/10.1016/S0091-6749(97)80008-5)
- [27] Anca Zanfrescu, Anca Ungurianu, Aristides M. Tsatsakis, George M. Nițulescu, Demetrios Kouretas, Aris Veskoukis, Dimitrios Tsoukalas, Ayse B. Engin, Michael Aschner, and Denisa Margină. 2019. A Review of the Alleged Health Hazards of Monosodium Glutamate. *Comprehensive Reviews in Food Science and Food Safety* 18, 4 (May 2019), 1111–1134. <https://doi.org/10.1111/1541-4337.12448>