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Consumption of Green and Black Tea: Potential Defenders Against Influenza: A Meta-Analytical Study

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Abstract

Introduction: Influenza is a significant global health challenge, impacting morbidity and mortality annually. Amidst the COVID-19 pandemic, influenza surveillance became pivotal for early detection. Tea catechins, present in both green and black teas, have garnered attention for their potential health benefits, including antioxidative and antimicrobial properties. Methods: This meta-analysis integrated data from randomized controlled trials and cohort studies to assess the effects of tea catechins on influenza prevention. Studies published between 2007 and 2020 were sourced from Google Scholar and PubMed, focusing on interventions such as tea consumption and capsule intake. Results: Meta-analysis revealed a significant protective effect of tea catechins against influenza, with an observed Odds Ratio (OR) of 0.60, indicating a 40% reduction in influenza risk associated with catechin consumption. Low heterogeneity ($I^2 = 18.5\%$) across studies supports the consistency of these effects. Tea catechins show promise in mitigating influenza due to their consistent efficacy across diverse studies. Future research should refine optimal dosages and explore synergies with vaccination strategies, emphasizing the need for broader population studies and long-term follow-ups. Conclusion: Regular consumption of green and black tea catechins offers a potential complementary approach to influenza prevention. Future research should focus on optimizing tea catechin use to enhance our ability to combat infectious diseases.

Keywords: Tea, Catechin, Influenza, Meta-Analysis, Odds Ratio

Introduction

Influenza infection is a serious infectious disease that significantly impacts morbidity and mortality worldwide every year. Among the three types of influenza, types A and B commonly cause seasonal outbreaks annually, while type C typically results in milder symptoms. During the prolonged COVID-19 pandemic (2019-2021), influenza identification became crucial as an early indicator for detecting COVID-19 in individuals. Although influenza is not the sole factor, influenza surveillance systems and public health preparedness plans are often utilized to monitor and respond to COVID-19. Prevention efforts, including vaccination and hygienic practices, remain key strategies but require enhanced effectiveness to combat the spread of these infectious diseases. Therefore, exploring alternatives or additional measures in influenza prevention is crucial.

Within tea, there exists an important compound known as catechin. In green tea, this compound is referred to as GTCs (Green Tea Catechins) and ECGC (epigallocatechin gallate), while in black tea, catechins undergo oxidation to form theaflavins and thearubigins (1). This difference arises during the fermentation process, resulting in varying polyphenol contents between green and black teas (2), although both types play similar roles in promoting health. Catechin content in tea has garnered significant attention due to its benefits in antioxidation, anti-inflammatory, anti-diabetes, anti-hypertension, anti-obesity, antimicrobial, and anti-tumor properties (3).

Several clinical studies have evaluated the effects of catechins on anti-influenza properties through various consumption methods, such as drinking brewed green tea, which has been

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clinically proven to reduce the duration and severity of upper respiratory tract infections (URTI) during winter seasons (4). Other methods include consuming tea capsules as dietary supplements or gargling with tea. Previous research (5) has considered the effects of catechins on URTI and influenza but has blurred the specific effects of tea or tea catechins on influenza alone. In addition, this research is also biased in statistical tests. Meanwhile, other studies (6) focused solely on green tea without involving black tea and exhibited varied routes of administration methods such as consumption, gargling, and capsule ingestion. Therefore, focusing exclusively on influenza, utilizing English-language inclusive articles, and addressing the aforementioned shortcomings can provide stronger, specific, and generalizable evidence regarding the preventive effects of tea or tea catechins on influenza. This new research can also help identify the most effective and safe administration methods for influenza prevention.

Method

The study selection process for this meta-analysis is depicted in the flowchart. Initially, a database search identified a total of 35 records, consisting of 2 records from the Cochrane Library, 9 records from PubMed, and 24 records from Google Scholar. After removing duplicates, 17 records remained for further screening. These 17 records were then screened and assessed for eligibility. Out of these, several studies were excluded for the following reasons. 5 full-text articles were excluded because they addressed URTI (Upper Respiratory Tract Infection) rather than influenza, 2 articles were in Japanese or Mandarin, 1 article had an unclear number of participants, and 2 articles utilized a gargling intervention method. After the selection and screening process, 7 studies were included in the meta-analysis, comprising 4 randomized controlled trials and 3 cohort studies.

This study utilized a combination of randomized controlled trials (RCTs) and cohort studies to investigate the effects of different interventions on influenza. The interventions included taking capsules and drinking tea (both green and black tea varieties).

Table 1 Data Source of Study

No	Author (year of publication)	Experiment	Mode Intervention	Duration	Study design	Events	Total Events	Events Control	Total Control	Total
1	Matsumoto (2011)	100 mg, By 200 μg/mL ×3 times, 500 mL	Taking Capsule	5	RCT	1	97	5	99	196
2	Park et al (2011)	137-685mg by 1-5cups/day	Drinking	4	Cohort	188	1954	16	96	2050
3	Delabre_black tea (2015)	Green tea or black tea Minimum of 2 times a week	Drinking	2	Cohort	12	142	77	979	1121
4	Delabre_green tea (2015)	Green tea or black tea Minimum of 2 times a week	Drinking	2	Cohort	8	193	81	928	1121
5	Furushima_flu e_high (2020)	57 mg catechins, including 20 mg EGCg, high-catechins: 3 times/day low-catechins: once/day	Drinking	3	RCT	1	84	4	86	256
6	Furushima_flu e_low (2020)	57 mg catechins, including 20 mg EGCg, high-catechins: 3 times/day low-catechins: once/day	Drinking	3	RCT	5	85	4	86	257
7	Rowe (2007)	*Camellia sinensis* formulation capsules including L-theanine and EGCg2 capsules/day	Taking Capsule	3	RCT	23	53	35	55	108

Table 1 shows that data were extracted from studies published between 2007 and 2020, sourced from Google Scholar and PubMed. For RCTs (Matsumoto, 2011 (7) and Rowe, 2007 (8)), participants were assigned to either a treatment group receiving capsules or a control group, with outcomes measured in terms of flu incidence. Cohort studies (Park et al.,2011(9), Delabre, 2015(10), and Furushima, 2020(11)) followed groups over time, recording flu events based on tea consumption habits. The chart will be shown in Figure 1.

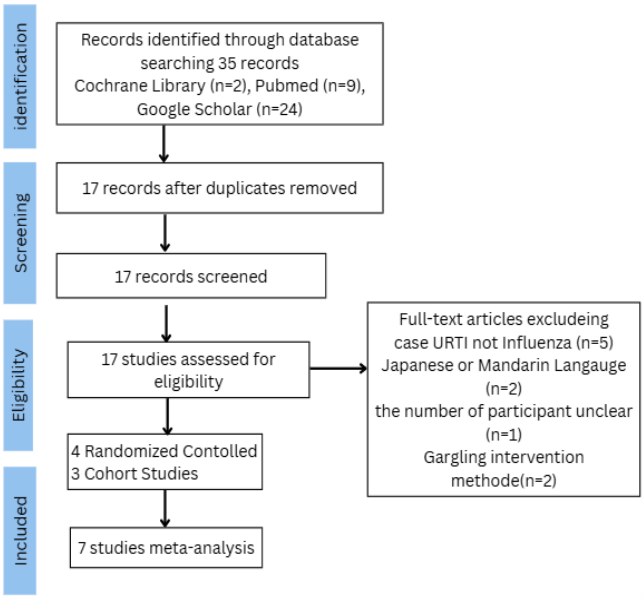

Figure 1 Systematic Reviews

The primary outcomes included the number of flu events observed among participants, along with the total number of participants in each study arm. Statistical analysis involved calculating odds ratios (OR) to assess the association between tea consumption and flu incidence, utilizing both fixed-effect and random-effects models to account for study heterogeneity. Data collection methods ensured that outcomes were systematically measured across diverse populations, providing robust insights into the preventive effects of tea catechins against influenza.

Results

Odds Ratio Test of Catechin's Effects on Influenza Across Seven Studies

Odds Ratio is a statistical measure used to assess the strength of the relationship between exposure to a risk factor or intervention and the occurrence of disease in case-control studies. This makes it highly relevant for combining results from studies with such designs in meta-analyses. In this study, the observed risk factor is exposure to influenza virus, with the cases observed being consumption of green and black tea in several studies. OR also provides a measure that is relatively easy to interpret in the context of disease risk. For example, an OR greater than 1 indicates a higher association between exposure and disease occurrence, while an OR less than 1 indicates protection or lower risk. Below are the results of the OR test on the forest plot observed.

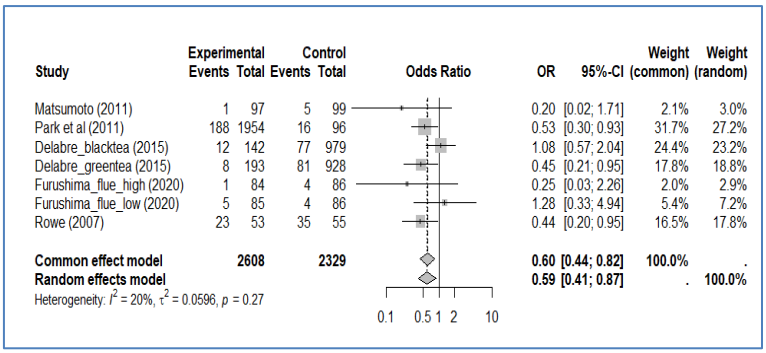

Figure 2 Forest Plot of OR Test

Figure 2 indicates that consumption of catechins from green and black tea is generally associated with a reduced risk of flu. Meta-analysis results show that the Odds Ratio (OR) for several studies indicates significant protection against flu infection, although the effect varies

among studies. Nearly all studies show low ORs (below 1), indicating that catechin consumption is associated with a significant decrease in flu risk. This suggests that catechins may have potential as a defense against flu. Despite variability in study outcomes, the analysis indicates low heterogeneity (I^2 = 18.5%), suggesting consistency in effects across the studies involved. Given that the p-value for the heterogeneity test is 0.14, which is greater than the 5% alpha level (0.05), this study uses a fixed-effect model. Therefore, the conclusion is that an OR of 0.60 means that consumption of catechins from green and black tea at specific doses significantly reduces the risk of influenza by 40%. In other words, each unit increase in exposure (consumption of green or black tea, whether consumed or taken as capsules) is associated with a 40% decrease in the likelihood of contracting flu.

Bias Test of Publication Across Seven Studies

Table 2 Output Bias Test of Study

	t-test	Df	p-value	bias estimate	SE
Value	-0.5	5	0.6388	-0.6091	1.22

Assessment of potential bias in a meta-analysis can be conducted using a t-test. The following is the output from the bias test is shown in Table 2. H0 (Null Hypothesis) indicates no significant bias in this meta-analysis. In this context, the mean bias value is zero, meaning there is no systematic bias affecting the results of the meta-analysis. Meanwhile, H1 (Alternative Hypothesis): There is significant bias in this meta-analysis. P-value > alpha will lead to rejecting H0 or finding bias in the study. However, the p-value in this study is 0.6388. This is the probability value indicating how significant this test is against the null hypothesis. In this context, a high p-value suggests there is insufficient evidence to reject the null hypothesis, meaning there is no significant evidence of bias in the meta-analysis.

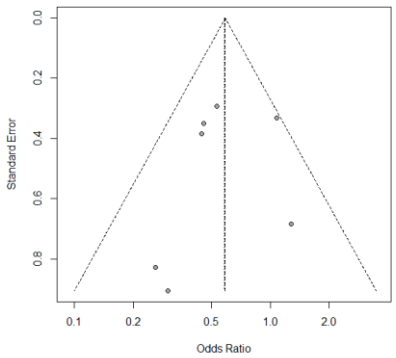

Figure 3 Funnel Plot of Meta Analysis

These results align with the funnel plot in Figure 3. The funnel plot shows there are a few studies with larger standard errors (towards the bottom), which is typical in meta-analyses. In summary, there appears to be no significant indication of publication bias in the studies included in your meta-analysis. The studies are reasonably symmetrical around the central effect size, suggesting consistency in the results across studies.

Discussion

Analyses of Results

The findings of this meta-analysis highlight significant insights into the potential role of tea catechins, particularly from green and black teas, in reducing the risk of influenza. The observed Odds Ratio (OR) of 0.60 indicates a substantial protective effect associated with catechin consumption, suggesting that these compounds could be beneficial in mitigating influenza

infections. One key aspect of this meta-analysis is the consistency in results across studies despite varying methodologies and populations. The low heterogeneity (I^2 = 18.5%) indicates that the effects of tea catechins on influenza prevention are relatively consistent, supporting the reliability and generalizability of the findings.

The discussion also addresses the implications of these findings in the context of public health. With influenza continuing to pose significant health challenges globally, identifying effective preventive measures is crucial. Tea catechins offer a promising avenue due to their multifaceted health benefits and relative safety profile.

Although this study has added to the shortcomings of previous studies, future research should focus on refining our understanding of optimal dosages and administration methods for tea catechins in influenza prevention. This includes investigating the specific mechanisms through which catechins exert their antiviral effects, as well as exploring potential synergies with existing influenza prevention strategies such as vaccination. Moreover, expanding the scope of research to include larger and more diverse populations, along with longer-term follow-ups, could provide further insights into the sustained effectiveness of tea catechins against influenza. Additionally, studies could explore the comparative effectiveness of green versus black tea catechins and evaluate other potential forms of catechin administration, such as capsules or extracts.

Conclusion

The regular consumption of catechins from green and black teas could play a role in reducing influenza risk. Further research focusing on optimal dosages and administration methods is warranted to strengthen these preventive strategies. This study has several limitations that need to be considered. This meta-analysis only includes seven studies that met the inclusion criteria thus the limited number of studies may restrict the generalization of findings to broader populations. Although heterogeneity among studies is relatively low (I^2 = 18.5%), differences in study designs and populations could influence the overall interpretation of the effects of tea catechins on influenza. The lack of adequate explanation regarding potential side effects of catechins at high doses is also a significant concern in the development of prevention strategies involving tea catechins. Limitations in available data from the covered studies and variations in data collection methods and outcome definitions could also affect the consistency and validity of findings. Nevertheless, this research provides valuable insights into the potential of tea catechins in reducing influenza risk, and future steps could include further research to broaden population coverage and optimize the use of tea catechins as part of a broader influenza prevention strategy.

Acknowledgment

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