International Journal of Food Sciences And Nutrition Innovations
Volume 1, Issue 2, 71-79.
e_ISSN: 3109-9025
https://e-journal.gomit.id/ijfsni

Effect of Tea Variety and Oxidation Duration on Oolong Tea Processed at PPTK Gambung Research Center

Mohammad Prasanto Bimantio*
Institut Pertanian Stiper Yogyakarta, Indonesia

Dika Aristian
Institut Pertanian Stiper Yogyakarta, Indonesia

Hilman Maulana
Pusat Penelitian Teh dan Kina Gambung, Indonesia

*** Corresponding author:**
Mohammad Prasanto Bimantio, Institut Pertanian Stiper, Indonesia. ✉bimantiomp@instiperjogja.ac.id

Article Info

Article history:

Received: October 10, 2025
Revised: November 18, 2025
Accepted: December 20, 2025

Keywords:

Antioxidant activity of tea
Camellia sinensis varieties
Oolong tea oxidation
Polyphenol content analysis
Sensory quality evaluation

Abstract

ABSTRACT
Background of study: Oolong tea is commonly produced from *Camellia sinensis* leaves, while the use of *assamica* variety has been rarely investigated. Differences in varietal composition and oxidation duration may influence chemical and sensory characteristics of oolong tea, particularly antioxidant activity and polyphenol content.
Aims and scope of paper: This study examined how tea variety and oxidation time effects of moisture content, polyphenols, antioxidant activity, and sensory properties of oolong tea. The scope included physicochemical and organoleptic evaluation to identify processing conditions that optimize functional quality.
Methods: A randomized block design with two factors was applied: tea variety (sinensis and assamica) and oxidation duration (15, 25, and 60 minutes), with four replications for each treatment. The measured parameters included moisture content, total polyphenols, antioxidant activity determined using the DPPH method, and sensory evaluation of color, aroma, and taste.
Result: Tea variety significantly affected moisture content, polyphenol levels, and antioxidant activity, while sensory differences were observed only for color. Oxidation duration significantly influenced antioxidant activity but did not affect moisture content or polyphenol levels. The highest antioxidant activity was observed in the assamica variety oxidized for 15 minutes, whereas longer oxidation durations resulted in reduced antioxidant activity.Conclusion: The assamica variety exhibited higher polyphenol content and antioxidant activity than sinensis. Shorter oxidation durations better preserved antioxidant activity, indicating that appropriate varietal selection combined with controlled oxidation can enhance the functional attributes of oolong tea.

To cite this article: Bimantio et all. (2025). Effect of Tea Variety and Oxidation Duration on Oolong Tea Processed at PPTK Gambung Research Center. *Journal of Food Sciences And Nutrition Innovations, 1*(2), 71-79.

INTRODUCTION

Background of the study:

Tea (*Camellia sinensis*) is one of the most consumed beverages worldwide and constitutes an important agricultural commodity in Indonesia, contributing economically while also providing raw material for food, health, and cosmetic industries (Anjarsari, 2016). Oolong tea occupies an intermediate position between green and black tea due to its partial oxidation stage, which affects biochemical transformation (Ng et al., 2018; Sun et al., 2020), color development, and antioxidant capacity (Lelita et al., 2018). Previously, Indonesian oolong teas have shown that high phenolic and flavonoid content relative to other tea types, indicating strong antioxidant potential (Dewi et al., 2023; Rustamsyah et al., 2024). Considering the growing interest in functional foods and natural antioxidants, research onprocessing factors that determine the quality of Indonesian oolong tea remains relevant.

Literature review:

Differences in tea varieties influence morphology, chemical composition, and functional bioactivity. The assamica variety generally contains higher catechin levels, whereas *sinensis* tends to exhibit more distinctive aroma due to its amino acid profile (Anjarsari, 2016). Such differences contribute to variation in polyphenol composition and antioxidant activity (Jiang et al., 2020; Yang et al., 2011), which subsequently affect quality characteristics.

Previous research has also indicated that moisture content, flavor attributes, and color development are shaped by enzymatic processes and thermal treatments used during oolong manufacture. During oxidation, enzymatic reactions modify catechins into *theaflavins* and *thearubigins*, thereby affecting both antioxidant activity and sensory characteristics (Anggraini et al., 2018; Lelita et al., 2018).

Previous studies have demonstrated that processing conditions, including oxidation duration, impact quality parameters in tea; however, most existing evidence focuses on green, black, or white tea rather than oolong derived from diverse botanical varieties (Rohdiana & Shabri, 2012). Several studies have examined antioxidant activity among tea types such as: green, black, oolong, and white, demonstrating different antioxidative capacities depending on processing intensity (Anggraini et al., 2018). Moreover, processing conditions particularly the degree of oxidation or heat treatment can substantially alter the phytochemical profile of the final tea product. Studies on differently processed teas highlight that oolong's chemical composition may shift toward green or black tea–like profiles depending on processing parameters (Zeng, 2024; Z. Zhao et al., 2024).

However, most of these comparisons treat tea categories generically rather than examining how chemical properties respond to specific processing variables within oolong tea itself. Furthermore, studies on polyphenol extraction, antioxidant assays, and enzymatic oxidation mechanisms have focused largely on green tea processing (Nugraheni et al., 2022), but fewer attempts have been made to translate these findings into comparative evaluations of *sinensis* versus *assamica* when processed under partially oxidized conditions.

Gap analysis:

Although oolong tea is traditionally manufactured from *sinensis*, *assamica* leaves are rarely used, resulting in limited empirical comparison of their chemical and sensory performance under standardized oolong-processing conditions (Bayani & Mujaddid, 2015). This represents a methodological gap, as varietal differences that are well-documented in green and black tea have not been sufficiently tested in oolong.

Previous studies have addressed antioxidant comparison among tea types, yet only a small number have systematically evaluated oxidation time as an independent factor influencing antioxidant retention in oolong tea (Nugraheni et al., 2022). Moreover, the interaction between botanical variety and oxidation duration has not been clearly established in the Indonesian context, despite Indonesia cultivating a considerable amount of *assamica*. Most available literature discusses chemical composition or fermentation effects separately, without integrating varietal and temporal variables in a controlled experimental design.

Rationale of the study:

Understanding varietal responses to oxidation duration is essential for optimizing processing parameters and improving functional quality attributes such as antioxidant capacity. Empirical information on moisture, polyphenols, and sensory preferences can support more informed raw material selection, encourage product innovation, and enhance the competitiveness of Indonesian oolong tea in domestic and international markets (Leslie & Gunawan, 2019).

Purpose or Hypotheses of the study:

This research aimed to determine the influence of tea variety (*sinensis* and *assamica*) and oxidation duration (15, 25, and 60 minutes) on physicochemical and sensory characteristics of oolong tea. It was hypothesized that (i) botanical variety significantly affects polyphenol content and antioxidant activity; (ii) longer oxidation decreases antioxidant performance due to enzymatic oxidation; and (iii) resulting chemical variations are reflected in selected organoleptic attributes

METHOD

Research Design:

This study employed a randomized block design consisting of two experimental factors, namely tea variety (*Camellia sinensis* and *Camellia assamica*) and oxidation duration (15, 25, and 60 minutes). Each treatment combination was replicated four times. The study examined differences in physicochemical and sensory characteristics of oolong tea resulting from the tested processing factors.

Participant:

Sensory evaluation involved a trained expert panel responsible for assessing color, aroma, and taste of the brewed tea samples. Panelists were familiar with tea sensory descriptors and were able to provide consistent evaluations based on predetermined scales.

Population and the methods of sampling Instrumentation:

The population consisted of oolong tea samples produced from two tea varieties commonly cultivated in Indonesian plantations. Sampling was purposive, targeting fresh leaf material obtained from *sinensis* and *assamica* plants at appropriate plucking maturity and processed under controlled laboratory conditions. Sensory data were collected using hedonic scoring scales evaluating appearance (color), aroma, and taste.

Instrument:

Analytical measurements included a drying oven for moisture determination, a UV–Vis spectrophotometer for antioxidant analysis using the DPPH method, and colorimetric analysis of total polyphenols employing Folin–Ciocalteu reagents. Standard laboratory glassware and weighing devices were used for quantitative procedures. Hedonic sensory scoring sheets were utilized for organoleptic assessment of brewed samples.

Procedures:

Fresh tea shoots from *Camellia sinensis* and *Camellia assamica* were collected at appropriate maturity and transported to the processing facility. The leaves were initially sun-withered for approximately 30 minutes, followed by indoor withering on withering troughs without the aid of forced air circulation for 14–18 hours to reduce leaf moisture content and increase leaf pliability.

After withering, leaves were subjected to mechanical rolling using bamboo rollers or rotary rolling equipment to disrupt cellular structures and promote the release of polyphenol oxidase, thereby initiating enzymatic oxidation. The rolling process was conducted for approximately 15 minutes until visible leaf bruising and characteristic aroma development were achieved.

Following rolling, leaves were allowed to undergo controlled oxidation for three designated time durations of 15, 25, and 60 minutes, respectively. During this stage, enzymatic reactions involving catechins and oxygen lead to the formation of oxidative pigments and modification of antioxidant compounds. The oxidation stage was performed under ambient conditions without forced airflow to approximate semi-fermentation processing typical of oolong tea.

After reaching the specified oxidation time, the leaves were heated in a rotary dryer for approximately five minutes to inactivate polyphenol oxidase and terminate further oxidation. Subsequently, the leaves underwent repeated short drying and rolling cycles using cloth wrapping and rotary dryers (5 minutes in the dryer and 5 minutes rolling), repeated four to five times, to stabilize leaf structure and prevent clumping.

Final drying was conducted in a mechanical dryer at approximately 100°C for one hour to achieve the required moisture reduction suitable for storage and analysis. The dried tea products were stored under controlled laboratory conditions until further analytical evaluation.

Chemical analyses included determination of moisture content using oven drying methods at 105°C, antioxidant activity evaluation using the DPPH radical scavenging assay measured spectrophotometrically at 517 nm, and total polyphenol analysis using the Folin–Ciocalteu colorimetric method. Sensory evaluation was conducted on brewed samples using expert panelists who assessed color, aroma, and taste through hedonic scoring procedures.

Analysis plan:

The data generated from physicochemical measurements were analyzed using analysis of variance (ANOVA) based on a randomized block design with two fixed factors, namely tea variety and oxidation duration. Where significant main effects were detected, multiple mean comparisons were performed using Duncan's Multiple Range Test (DMRT) at a 5% level of significance to determine statistically different treatments. The analysis focused on comparing treatment means across factorial combinations and identifying the influence of variety and oxidation time on moisture content, polyphenols, antioxidant activity, and sensory responses.

Scope and/or limitations of the methodology:

The study was limited using only two botanical varieties, thus restricting the generalization of findings to other commercial clones. While oxidation time was systematically varied, other processing variables, such as temperature fluctuations, leaf maturity variability, and environmental conditions during withering were not experimentally controlled beyond standard practice, potentially contributing to variability in chemical responses.

Sensory evaluation was conducted using a relatively small expert panel, which enhances evaluative precision but may limit broader consumer representativeness. Instrumental analyses focused on moisture, antioxidant activity, and total polyphenols; therefore, other potentially relevant compounds (e.g., catechin fractions, volatile aroma constituents, caffeine levels) were not measured.

Additionally, the study did not evaluate long-term storage effects or potential interactions with post-processing packaging conditions, meaning conclusions apply primarily to freshly processed tea.

RESULTS AND DISCUSSION

Results:

The quantitative analysis showed that moisture content ranged between 1.68% and 2.78% as shown in table 1, and the values differed significantly between the two botanical varieties tested. Moisture tended to be higher in sinensis, while *assamica* showed lower levels under similar oxidation times. Oxidation duration did not produce statistically significant differences in moisture, although a slight upward trend was observed with longer oxidation intervals.

Table 1. Moisture content (%)

Oxidation time (min)	Tea variety		Average
	C. sinensis	*C. assamica*	
15	1.90	1.75	1.83
25	1.95	1.85	1.90
60	2.78	1.68	2.23
Average	2.21	1.76	

Based on table 2, polyphenol concentrations varied from 19.18% to 24.10%, with significantly higher values recorded for *assamica* across oxidation treatments. The oxidation time did not show a significant effect on total polyphenols, indicating that the measurable phenolic fraction remained relatively stable within the tested time limits.

Table 2. Polyphenol concentrations (%)

Oxidation time (min)	Tea variety		Average
	C. sinensis	*C. assamica*	
15	19.75	22.53	21.14
25	19.58	23.58	21.58
60	19.18	24.10	21.64
Average	19.50	23.40	

Antioxidant activity demonstrated clearer treatment effects and displayed sensitivity to both variety and oxidation time. The highest measured antioxidant value was recorded for *assamica* oxidized for 15 minutes (57.21%), whereas the lowest value appeared in *sinensis* oxidized for 60 minutes (42.28%). A consistent decline in antioxidant activity was observed as oxidation time increased as shown in table 3.

Table 3. Antioxidant activity (%)

Oxidation time (min)	Tea variety		Average
	C. sinensis	*C. assamica*	
15	51.18	57.21	54.19[c]
25	44.87	52.20	48.53[b]
60	42.28	48.30	45.29[a]
Average	46.11	52.57	

Sensory evaluation revealed that color was the only attribute showing a significant varietal effect, with *assamica* receiving slightly higher scores, result shown in table 4. In contrast, aroma and taste did not exhibit significant differences attributable to either variety or oxidation time. Panelists tended to provide neutral evaluations across aroma and taste categories, indicating minimal perceptual variation under tested conditions.

Table 4. Sensory evaluation for color

Oxidation time (min)	Tea variety		Average
	C. sinensis	*C. assamica*	
15	5.00	5.08	5.04
25	4.81	5.21	5.01
60	4.79	4.98	4.88
Average	4.87	5.09	

Discussion:

The significant varietal effect on moisture, polyphenols, and antioxidant activity suggests that biochemical composition inherent to tea varieties plays a determining role in final product quality. The lower moisture content in assamica may be associated with leaf morphology or cellular structure, which could influence intracellular water distribution and drying efficiency. Higher polyphenols in assamica corroborate previous research showing elevated catechin concentrations in this variety (Anjarsari, 2016), supporting its potential suitability for functional tea products.

The absence of a significant oxidation effect on total polyphenols may be explained by the possibility that polyphenol oxidation does not immediately translate into losses in total measurable phenolics, since oxidized phenolic intermediates (e.g., *theaflavins*, *thearubigins*) may still be detected in total phenolic assays (Dominguez-López et al., 2024; Haslam, 2003). During oxidation, enzymatic reactions modify catechins into theaflavins and thearubigins, altering antioxidant functionality while maintaining overall phenolic stability (Theppakorn, 2016). Therefore, although oxidation reduces antioxidant activity, the measurable total phenolic content may remain relatively stable. This interpretation corresponds with the theoretical understanding that polyphenol oxidase catalyzes conversion rather than degradation of phenolic compounds. The sensitivity of phenolic profile to processing conditions is consistent with the notion that oxidation and heat treatment can shift phytochemical composition substantially (Z. Zhao et al., 2024).

The pronounced decline in antioxidant activity as oxidation time increased aligns with established biochemical reactions in tea processing (Donlao & Ogawa, 2019), where longer exposure to oxygen accelerates conversion of catechins into oxidized phenolics with lower radical-scavenging capacity (Anggraini et al., 2018; Lelita et al., 2018). The sharp contrast between short and long oxidation suggests that antioxidant efficacy is highly time-sensitive during early enzymatic oxidation stages. The decline of antioxidant activity with longer oxidation time observed in this study corresponds well with findings from other work showing that oolong tea infusions with higher catechin contents produce stronger radical scavenging (Su et al., 2007). As shown by Salman et al. (2022), extended fermentation (oxidation) significantly reduces catechin content and alters antioxidant profiles in tea types.

The sensory results showing that only color was significantly affected imply that oxidation-induced pigment formation (e.g., *theaflavins* and *thearubigins*) may be more visually detectable than aroma- or flavor-related compounds at the tested processing durations. Limited observable changes in aroma and taste could reflect the relatively short oxidation times applied, which may not have been sufficient to generate strong sensory differentiation detectable by expert panelists (Obanda et al., 2001).

Taken together, the findings indicate that *assamica* may offer greater functional advantages in oolong processing when shorter oxidation is used. These results suggest a combined varietal–process optimization strategy, in which botanical selection and controlled oxidation time can be tailored depending on desired functional and sensory objectives. Consistent with Zhao et al. (2019), our results suggest that moderate oxidation in oolong tea maintains significant phenolic content but reduces overall antioxidant capacity compared to unoxidized green tea

Implications:

The findings have practical implications for local tea processing industries. Shorter oxidation duration can preserve antioxidant quality, suggesting potential development of functional oolong tea products with enhanced health attributes. Recent studies have reported a direct correlation between oxidation degree and antioxidant capacity, suggesting partial oxidation maintains more phenolics than full fermentation (Granato et al., 2018; Parveen et al., 2023).

The use of *assamica* as an alternative raw material demonstrates promising functional potential, supporting diversification beyond the commonly used *sinensis* variety. These results provide a scientific basis for refining local processing methods and improving product competitiveness in specialty and functional beverage markets.

Research contribution :

This study contributes empirical evidence on the combined influence of botanical variety and oxidation duration in oolong tea processing, an area where research remains limited. It provides experimentally controlled comparisons between *sinensis* and *assamica*, offering insights relevant to raw-material selection, processing optimization, and functional product development. The work extends previous research by systematically integrating varietal and temporal processing variables, filling an important knowledge gap in Indonesian oolong tea studies.

Limitations:

The study examined only two varieties and three oxidation times, restricting broader generalization. Analytical focus was limited to moisture, polyphenols, and antioxidant activity, without assessment of specific catechin fractions, volatile aroma compounds, or caffeine levels. Sensory evaluation used a trained panel rather than consumer testing, which may limit application to wider preference patterns. Environmental variation during leaf withering and differences in leaf maturity were controlled operationally but not experimentally, potentially contributing to variation.

Suggestions:

Future studies may include a wider range of tea varieties or clones, as well as additional biochemical parameters such as catechin profiles, volatile compounds, and caffeine. Consumer-based sensory evaluation would provide broader preference insights beyond expert assessment. Further work is recommended to examine post-processing storage stability, packaging effects, and long-term antioxidant degradation under commercial distribution conditions. Oxidation modeling and enzymatic kinetics could also be explored to deepen scientific understanding of biochemical transformations during oolong processing.

CONCLUSION

The present study aimed to determine whether botanical variety and oxidation duration influence physicochemical and sensory characteristics of oolong tea. The findings support the initial expectation that varietal differences play a determining role in polyphenol composition and antioxidant capacity, while oxidation time particularly affects antioxidant activity. These results align with the hypotheses proposed in the Introduction and confirm that *Camellia assamica* possesses higher polyphenol and antioxidant values than *Camellia sinensis*, thus demonstrating its suitability as an alternative raw material for oolong tea production.

The study also demonstrated that shorter oxidation duration (15 minutes) preserved antioxidant activity more effectively than longer oxidation periods. This confirms the prediction that prolonged oxidation leads to the enzymatic transformation of catechins, thereby decreasing their radical-scavenging ability. Meanwhile, total polyphenols remained relatively stable and sensory differences were detected mainly in infusion color, indicating that visual attributes are more responsive to varietal and processing conditions than aroma or taste under the tested parameters.

From a developmental perspective, these findings suggest that optimizing oolong tea processing should involve both varietal selection and precise control of oxidation time. The use of *assamica*, which has traditionally been less common in oolong production, appears promising for developing functional tea products with enhanced antioxidant properties. Accordingly, the research provides a scientific basis for diversifying raw material utilization in Indonesian tea processing and supports innovation in specialty beverage segments.

In terms of future research prospects, further study is recommended to investigate oxidation kinetics, broader biochemical profiles, volatile aroma compounds, and consumer-based sensory acceptance to complement expert evaluations. Expanding research to include diverse clones and post-processing storage stability will also strengthen the application of these findings in industrial practice. In this way, the study not only provides empirical evidence consistent with its initial hypotheses, but also opens practical pathways for product development, processing improvement, and the advancement of locally produced oolong tea in domestic and global markets.

AUTHOR CONTRIBUTION STATEMENT

DA desig ned the study, performed sample preparation and laboratory analysis, and drafted the manuscript. MB contributed to research design, supervised the experimental process, and revised the manuscript critically for important intellectual content. HM provided technical support during tea processing, contributed to data interpretation, and reviewed the final manuscript. All authors approved the submitted version and agreed to be accountable for all aspects of the work.

REFERENCES

Anggraini, L. D., Rohadi, R., & Putri, A. S. (2018). Komparasi sifat antioksidatif seduhan teh hijau, teh hitam, teh oolong dan teh putih produksi pt perkebunan nusantara ix. *Jurnal Teknologi Pangan Dan Hasil Pertanian*, *13*(2), 10–21. https://doi.org/10.26623/jtphp.v13i2.2379

Anjarsari, I. R. D. (2016). Katekin teh Indonesia: Prospek dan manfaatnya. *Kultivasi*, *15*(2), 99–106. https://doi.org/10.24198/kultivasi.v15i2.11871

Bayani, F., & Mujaddid, J. (2015). Analisis Fenol Total Teh Hijau Komersial (Camellia sinensis L). *Hydrogen: Jurnal Kependidikan Kimia*, *3*(2), 318–323. https://doi.org/10.33394/hjkk.v3i2.691

Dewi, K. A. S., Yusasrini, N. L. A., & Hatiningsih, S. (2023). Karakteristik Teh Oolong Organik Celup (Camellia sinensis) dengan Perbedaan Waktu Oksidasi Enzimatis. *Itepa: Jurnal Ilmu dan Teknologi Pangan*, *12*(2), 263–277. https://doi.org/10.24843/itepa.2023.v12.i02.p04

Dominguez-López, I., Pérez, M., & Lamuela-Raventós, R. M. (2024). Total (poly)phenol analysis by the Folin-Ciocalteu assay as an anti-inflammatory biomarker in biological samples. *Critical Reviews in Food Science and Nutrition*, *64*(27), 10048–10054. https://doi.org/10.1080/10408398.2023.2220031

Donlao, N., & Ogawa, Y. (2019). The influence of processing conditions on catechin, caffeine and chlorophyll contents of green tea (*Camelia sinensis*) leaves and infusions. *LWT*, *116*, 108567. https://doi.org/10.1016/j.lwt.2019.108567

Granato, D., Shahidi, F., Wrolstad, R., Kilmartin, P., Melton, L. D., Hidalgo, F. J., Miyashita, K., Camp, J. van, Alasalvar, C., Ismail, A. B., Elmore, S., Birch, G. G., Charalampopoulos, D., Astley, S. B., Pegg, R., Zhou, P., & Finglas, P. (2018). Antioxidant activity, total phenolics and flavonoids contents: Should we ban in vitro screening methods? *Food Chemistry*, *264*, 471–475. https://doi.org/10.1016/j.foodchem.2018.04.012

Haslam, E. (2003). Thoughts on thearubigins. *Phytochemistry*, *64*(1), 61–73. https://doi.org/10.1016/s0031-9422(03)00355-8

Jiang, H., Zhang, M., Wang, D., Yu, F., Zhang, N., Song, C., & Granato, D. (2020). Analytical strategy coupled to chemometrics to differentiate Camellia sinensis tea types based on phenolic composition, alkaloids, and amino acids. *Journal of Food Science*, *85*(10), 3253–3263. https://doi.org/10.1111/1750-3841.15390

Lelita, D. I., Rohadi, R., & Putri, A. S. (2018). SIFAT ANTIOKSIDATIF EKSTRAK TEH (Camellia sinensis Linn.) JENIS TEH HIJAU, TEH HITAM, TEH OOLONG DAN TEH PUTIH DENGAN PENGERINGAN BEKU (Freeze Drying). *Jurnal Teknologi Pangan Dan Hasil Pertanian*, *13*(1), 15–30. https://doi.org/10.26623/jtphp.v13i1.2372

Leslie, P. J., & Gunawan, S. (2019). Uji fitokimia dan perbandingan efek antioksidan pada daun teh hijau, teh hitam, dan teh putih (Camellia sinensis) dengan metode DPPH (2,2-difenil-1- pikrilhidrazil). *Tarumanagara Medical Journal*, *1*(2), 383–388. https://doi.org/10.24912/tmj.v1i2.3841

Ng, K.-W., Cao, Z.-J., Chen, H.-B., Zhao, Z.-Z., Zhu, L., & Yi, T. (2018). Oolong tea: A critical review of processing methods, chemical composition, health effects, and risk. *Critical Reviews in Food Science and Nutrition*, *58*(17), 2957–2980. https://doi.org/10.1080/10408398.2017.1347556

Nugraheni, Z. V., Rachman, T. M., & Fadlan, A. (2022). Ekstraksi Senyawa Fenolat dalam Daun Teh Hijau (Camellia Sinensis). *Akta Kimia Indonesia*, *7*(1), 69–76. https://doi.org/10.12962/j25493736.v7i1.12557

Obanda, M., Okinda Owuor, P., & Mang'oka, R. (2001). Changes in the chemical and sensory quality parameters of black tea due to variations of fermentation time and temperature. *Food Chemistry*, *75*(4), 395–404. https://doi.org/10.1016/S0308-8146(01)00223-0

Parveen, A., Qin, C.-Y., Zhou, F., Lai, G., Long, P., Zhu, M., Ke, J., & Zhang, L. (2023). The Chemistry, Sensory Properties and Health Benefits of Aroma Compounds of Black Tea Produced by Camellia sinensis and Camellia assamica. *Horticulturae*, *9*(12), 1253. https://doi.org/10.3390/horticulturae9121253

Rohdiana, D., & Shabri, S. (2012). Analysis of individual cathecin from green tea extracted and fractionated by column chromatography. *Jurnal Sains Teh Dan Kina*, *15*(2). https://doi.org/10.22302/pptk.jur.jptk.v15i2.24

Rustamsyah, A., Perdana, F., Zakiah, A., & Khairunnisa, A. (2024). ANALISIS KADAR TOTAL FENOL DAN FLAVONOID PADA PRODUK TEH OOLONG YANG BEREDAR DI PASARAN: Analysis Total Phenol And Total Flavonoid Contents In Some Oolong Tea Products On The Market. *Jurnal teknologi pangan dan ilmu pertanian (JIPANG)*, *6*(1), 1–6. https://doi.org/10.36526/jipang.v6i1

Salman, S., Öz, G., Felek, R., Haznedar, A., Turna, T., & Özdemir, F. (2022). Effects of fermentation time on phenolic composition, antioxidant and antimicrobial activities of green, oolong, and black teas. *Food Bioscience*, *49*, 101884. https://doi.org/10.1016/j.fbio.2022.101884

Su, X., Duan, J., Jiang, Y., Duan, X., & Chen, F. (2007). Polyphenolic Profile and Antioxidant Activities of Oolong Tea Infusion under Various Steeping Conditions. *International Journal of Molecular Sciences*, *8*(12), 1196–1205. https://doi.org/10.3390/i8121196

Sun, H., Wang, H., Zhang, P., Ajlouni, S., & Fang, Z. (2020). Changes in phenolic content, antioxidant activity, and volatile compounds during processing of fermented sorghum grain tea. *Cereal Chemistry*, *97*(3), 612–625. https://doi.org/10.1002/cche.10277

Theppakorn, T. (2016). Stability and chemical changes of phenolic compounds during Oolong tea processing. *International Food Research Journal*, *23*, 564–574.

Yang, C. S., Wang, H., Li, G. X., Yang, Z., Guan, F., & Jin, H. (2011). Cancer prevention by tea: Evidence from laboratory studies. *Pharmacological Research*, *64*(2), 113–122. https://doi.org/10.1016/j.phrs.2011.03.001

Zeng, J. (2024). Research Progress on the Antioxidant Activity of Oolong Tea. *BIO Web of Conferences*, *124*, 01012. https://doi.org/10.1051/bioconf/202412401012

Zhao, C.-N., Tang, G.-Y., Cao, S.-Y., Xu, X.-Y., Gan, R.-Y., Liu, Q., Mao, Q.-Q., Shang, A., & Li, H.-B. (2019). Phenolic Profiles and Antioxidant Activities of 30 Tea Infusions from Green, Black, Oolong, White, Yellow and Dark Teas. *Antioxidants*, *8*(7), 215. https://doi.org/10.3390/antiox8070215

Zhao, Z., Chen, R., & Ng, K. (2024). Effects of Differently Processed Tea on the Gut Microbiota. *Molecules*, *29*(17), 4020. https://doi.org/10.3390/molecules29174020