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The potential of spiced tea for health

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ABSTRACT

Tea (*Camellia sinensis*) is one of the most important commodities in the world, including in Indonesia. Tea products contain polyphenols, an antioxidant beneficial for health. Nowadays, tea product diversification has gain market and increased consumer acceptance due to its functional benefits besides flavour. The use of spices in tea is widely applied not only to add flavour, but also to increase its functional value. Various bioactive components contained in spices can be used as fragrances, flavour enhancers, preservatives, and natural colouring. This review explores the potential benefit of adding spices into tea (*Camellia sinensis*) to enrich previous studies on tea and to support development of *Camellia sinensis*-based tea in Indonesia.

Introduction

Tea is one of the most popular beverage worldwide besides coffee. Tea, which is produced from *Camellia sinensis* leaves has a wide market and continuously improving globally. Based on the type of processing process, there are several types of tea, with the three most famous i.e. green tea, oolong tea and black tea (Abudureheman et al., 2022). Black tea that is produced through fermentation (term used for enzymatic oxidation in tea) contains flavonoids called catechins which have antioxidant properties and play an important role in fighting free radicals. Several studies have stated that the active compounds in tea can prevent various diseases, such as reducing cholesterol levels, preventing heart disease and having the potential as antioxidants (Martono and Setiyono, 2014).

Tea production in Indonesia showed fluctuation annually with the decreasing trend in the last five years (The Ministry of Agriculture RI, 2022) and the export of tea had also decreased in the same period (BPS, 2021), showing the need of improvement, one of this effort is by product diversification. Product diversification of tea (*Camellia sinensis*) is currently being carried out in line with the development of technology and the increasing consumer desire for new products with more functional value. Some of them are for example by giving a new appearance or shape, taste, taste and increasing the health benefits (De et al., 2019). Adding ingredients such as spices into black tea to produce "spiced tea" or tea added/enriched with spices can increase its functional value and benefit to human body. An example is the addition of lemongrass (De et al., 2019) or turmeric (Bhandari et al., 2019) to black tea. Several commercial tea products have also been formulated with spices, for example chai tea, masala tea, or tea with the addition of other spices. Gupta et al. (2014) conveyed the addition of spices to black tea, including to improve the taste and health benefits. Other studies also reported the addition of spices such as ginger, lemongrass, nutmeg, lemon cinnamon, ginger, masala tea, rosemary to black tea (Ochanda et al., 2015a) and continued with the addition of spices to purple tea, which is *Camelia sinensis* tea leaves but has a purple color and can increase antioxidant levels. Based on previous studies, it can be stated that the addition of spices to tea has potential to increase the functional health benefits of tea.

Indonesia is one of world producers of spices and therefore, there are lots of potentials of using local spices for food and beverage products. These spices can be a source of natural antioxidants that have many benefits for human body. Antioxidants are substances that can stabilize, deactivate and ward off free radicals (Pebiningrum and Kusnadi,

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2018). Several types of locally available spices that are considered to have high bioactive compounds are cinnamon, cardamom, ginger, and cloves. ardamom The combination of tea and spices is expected to produce enriched tea that is not only being more acceptable from a sensory point of view due to flavor or aroma improvement but also offers more functional value for the body or health. It is understood that there are previous publications on tea and/or spices. However, there is still limited research published on the spiced tea or tea enriched with spices using local spices commodities grown in Indonesia. Beside enriching previous studies on tea, this review may support development of *Camellia sinensis*-based tea in Indonesia. It is also important to provide information as the foundation for further research.

Results and Discussion

Tea And Its Category

Tea (*Camellia sinensis*) is mentioned as an important export commodity for Indonesia, with an export volume of 45.265 thousand tons in 2020 which represents an increase of 5.73% from the previous year's exports (BPS, 2020). However, in 2021, tea export was decreased to 42.65 thousand tons, a reduction of 7.43% (BPS, 2021). Dry tea production in Indonesia in 2021 had reached 145.1 thousand tons, which showed an increase of 13.45% from the previous year, with the major producer from West Java province (BPS, 2021).Several types of tea are produced in Indonesia, for example black tea, oolong tea, green tea, and white tea (Prawira et al., 2021). All of them are processed from the *Camellia sinensis* plants, particularly the leaves.

Different from the so-called true tea produced solely from *Camellia sinensis*, spiced tea, the term used in this review, is another category of tea which has been added or enriched with spices. These added spices provide more diverse flavour and functional benefit for human body and attract more consumers nowadays, in replace to herbal drink or traditional medicine.

Spice teas generally have a colour that is not very attractive and tend to be brown or cloudy brown due to the dried spices. The spices used as ingredients for making herbal teas may include ginger (*Zingiber officinale*) which has high natural antioxidant compounds and is efficient in inhibiting free radicals produced by cancer cells. Traditional medicine utilizes ginger (*Zingiber officinale*) for a variety of ailments, including the treatment of headaches, the treatment of colds, and the stimulation of appetite (Srinivasan, 2017). When compared to other rhizomes, this spicy rhizome has the highest antioxidant potential (Sunaryo et al., 2015). Because it contains zingerone as ketone component, ginger has a tangy spice taste. Oleoresin, which is found in ginger, is a flavor and aroma transporter as well as an antioxidant (Suseno et al., 2018). Cinnamon (*Cinnamomum burmannii*) contains chemical compounds in the form of phenols, terpenoids and saponins, which are sources of antioxidants. Cloves (*Syzygium aromaticum*) contain essential oils and other chemical compounds such as eugenol, oleanolic acid, and gallotannic acid. Cardamom (*Amomum cardamomum*) contains 3-7% essential oil which is efficacious for treating dental diseases and urinary tract infections (Prabowo et al., 2022).

Herbal tea, including tisane, is commonly used for tea that is not derived from *Camellia sinensis* plant. This tea is made from one or more herbal ingredients intended for oral water consumption and is prepared by decoction, infusion or maceration. Different plant parts such as fresh or dried fruit, leaves, flowers, roots, seeds and stems are used to manufacture aqueous extracts. The availability and consumption of tea are increasing due to various fermentation techniques and a variety of herbal tea plants (Malongane et al., 2017)

Potency of Spices Used in Tea

As discussed in the previous section, the use of spices in tea is widely applied not only to add flavour but also to increase its functional value. Various bioactive components contained in spices can be used as fragrances, taste enhancers, preservatives, colourants and nutritious for health. Generally, spices have high antioxidant activity, which is their main benefit towards human health. Various studies on tea combined with spices have been carried out. Functional drinks made from a combination of jackfruit leaves, cardamom, cloves, and deaf are able to inhibit the formation of free radicals. Based on research conducted, jackfruit leaf herbal teas and spices have a very strong antioxidant capacity of 60381-69611 ppm (Putri et al., 2021). The higher the ratio of spices used, the higher the antioxidant activity and other bioactive compounds presents in the tea produced. However, the incorporation of spices into tea should also

consider sensory acceptance for the pleasant consumption

One of the local spices available in Indonesia is cardamom. This spice contains various volatile compounds such as cineol, terpineol, borneol, and antioxidant compounds, including saponins, polyphenols, and flavonoids (Bermawie, 2020). According to Muna et al. (2019), cardamom fruit extract has strong antioxidant activity from the IC_{50} value of 26.60 ppm. Another popular abundant spice to be used in food and beverage in Indonesia is cloves. Clove is a spice with a high phenolic content (70-80% eugenol), which is an antioxidant. The eugenol compound comprises other active compounds, including saponins, flavonoids, tannins, and essential oils (Ryadha et al., 2021). These active components are natural antioxidants that positively affect health, protect from the dangers of free radicals, and reduce the risk of various diseases (Lumingkewas et al., 2014). The potential of spices used in tea is shown in Table 1.

Spices are widely combined with various raw materials, including tea, due to its high antioxidant activity. An antioxidant is a compound that, in a certain amount, can inhibit or prevent damage due to oxidation reactions. Antioxidants can inactivate lipid free radicals and prevent the breakdown of hydroperoxides into free radicals (e.g. phenolic compounds). In addition, antioxidants can increase the activity of other antioxidants (e.g., citric acid and ascorbic acid), act as metal chelating agents in inactive compounds (e.g. phosphoric acid and citric acid), and can reduce hydroperoxides (e.g. proteins and amino acids) (Sayuti and Yenrina, 2015). Although it was believed that mixing spices with tea would increase its antioxidative benefits, a decline in activity was found when the two ingredients were paired with (Ochanda et al., 2015a). The amount of the spices was discovered to be negatively linked with the spiced tea's antioxidant activity (Ochanda et al., 2015b). This was in contrast to the earlier discovery, which showed that the two antioxidant compounds worked together synergistically to increase antioxidant capabilities.

The antioxidants contained in spices are classified as natural antioxidants and are usually obtained from plant parts such as leaves, flowers, fruit, bark, seeds, and roots. Those classified as natural antioxidants include vitamin A, vitamin C, vitamin E, and phenolic compounds (Asif, 2015). As antioxidants, phenolic compounds serve as reducing agents, free radical scavengers, reducing the formation of singlet oxygen and electron donors. Consumption of antioxidants in sufficient quantities has been shown to reduce the risk of degenerative diseases, namely cardiovascular, cancer, atherosclerosis, and osteoporosis (Sayuti and Yenrina, 2015).

Honey in Tea

Another interesting point is the addition of honey into tea. The addition of sweetness is also generally known to improve the taste of drinks. The use of honey can be suggested to sweeten tea as a healthier way of tea consumption with the preferred sweet taste. Honey has high sugar content in the form of fructose, glucose and sucrose. Honey also contains several enzymes such as catalase, glucose oxidase and peroxidase. The non-enzymatic content of honey includes carotenoids, amino acids, proteins, organic acids, Maillard reaction products and more than 150 polyphenolic compounds, including flavonoids, flavanols, phenolic acids, catechins, and cinnamic acid derivatives. In the research of Pebiningrum and Kusnadi (2018), it is known that the addition of honey affects pH, total sugar, total phenol, and antioxidant activity in the ginger kombucha. The resulting pH values ranged from 4.34 - 4.75. Honey contains acids such as gluconic, acetic, butyric, lactic, citric and formic acids. In the total sugar test, the results ranged from 22.87% - 47.81%. This value tends to be influenced by the addition of honey according to the added concentration. Analysis of total phenol average ranged from 226.55 – 563.50 ppm. Honey has 150 polyphenolic compounds which indicate high levels of total phenol in honey. The average antioxidant activity of ginger kombucha with the addition of honey was around 63.07-83.81%. Where the ginger extract only ranged from 58.84 - 75.61%. This is supported by the research of Toydemir et al. (2015), where the addition of honey (flower and pine honey) into 9 different herbal tea samples showed that the total phenol content and antioxidant activity of tea samples added with honey were generally higher than control tea samples. These findings support using honey as a natural sweetener in tea drinks to benefit from its health-enhancing antioxidant properties.

Table 1. Research results on the potential of spices used in tea

Material	Chemical Component and Benefit of Spices used in Tea	Research result	Reference
Green tea-stevia-spices (ginger, cinnamon, clove)	● Cinnamon = contains eugenol, cinnamic aldehyde, beta-caryophyllene ● Ginger = contains gingerols, and diarylheptanoids. ● Clove = contains eugenol, eugenol acetate, benzyl alcohol	Tea with the selected formulation (the ratio of ginger and cloves is more than cinnamon) produces antioxidant levels of 157–163 mg of phenol/serving with low calories of about 30–111 cal/serving	(Ariviani and Ishartani, 2009)
Spices (ginger, nutmeg, cinnamon, clove, lemongrass, cardamom)-natural dyes (rosella, beetroot, butterfly pea)	● Ginger = contains natural antioxidant ● Nutmeg = contains alkaloid group, vitamin C ● Cinnamon = contains phenol, terpenoid, saponin ● Clove = contains eugenol, oleanolic acid, gallotanic acid, phenylene, caryophyllene, resin, and gum. ● Lemongrass = contains essential oil ● Cardamom = contains essential oil such as terpineol, terpinyl acetate, cineol, alpha borneol, and beta camphor.	The composition of the spice has an effect on the antioxidant activity of the spiced tea produced (highest activity = 65.0091%) and the presence of natural dye from rosella is able to maintain the antioxidant content of the spiced tea.	(Prabowo et al., 2022)
Black tea-red ginger	Red ginger contains antioxidant compounds such as 6-gingerol, 8-gingerol, 10-gingerol and 6-shogaol, zingiberene, and zingiberol.	Spiced tea contains total phenols ranging from 176.14-297.12 mgGAE/g, total flavonoids ranging from 169.50 mgQE/g-541.81 mgQE/g, antioxidant activity from 58.74-84.85%	(Savitri et al., 2019)
Cinnamon tea	Cinnamon contains unique healthy and healing property due to the presence of active component	Cinnamon tea contains polyphenol about 74.62 ppm, total tannin of 45 ppm, and antioxidant activity about 94.82 mg/ml (antioxidant activity is higher than general tea)	(Ahmad et al., 2016)
Cardamom tea	Helps treat indigestion, prevents stomach pain, and relieves flatulence	Cardamom tea contains polyphenol about 58.98 ppm, total tannin of 33.87 ppm, and antioxidant activity about 90.33 mg/ml (antioxidant activity is higher than general tea)	(Ahmad et al., 2016)
Ginger tea	Acts as an energizer and a stimulator for digestive system	Cinnamon tea contains polyphenol about 68.46 ppm, total tannin of 32.37 ppm, and antioxidant activity about 86.33 mg/ml	(Ahmad et al., 2016)
Black tea-ginger-black pepper-tulsi	● Ginger = gingerols and shogaols are responsible for strong antioxidant activity ● Black pepper = piperine acts as flavoring agent and have many phytochemicals compounds ● Tulsi (*Ocimum sanctum*) = contains linalool, eugenol, methyl chavicol, cineole that contributes to antioxidant activity and responsible for inhibition of lipid peroxidation	The combination of black tea:ginger:black pepper:tulsi (1:1:1:1) shows high antioxidant activity of 98.72%	(Gupta et al., 2014)

Additionally, honey's numerous therapeutic characteristics which including antioxidant, antibacterial, hepatoprotective, hypoglycemic, reproductive, and antihypertensive is considerably utilized to treat human problems. It is recognized as an ancient form of traditional medicine produced by *Apis mellifera* (*A. mellifera*) (Mushtaq et al., 2020). Honey has antimicrobial abilities which can perform well with spiced teas. According Rohi et al. (2017), spiced tea, which combines green tea with honey and ginger in methanol extract, was reported to be effective against both of the investigated bacterial pathogens (*Staphylococcus aureus* and *Pseudomonas aeruginosa*). On the other hand, green tea distilled water extracts performed substantially lower. In addition to the varied bioactive content, honey has various taste and sensory properties. It is influenced by the source of nectar and the harvest method. These sensory characteristics are associated with higher concentrations of compounds such as HMF, hotrienol, and pyranone, which are produced from heat and postharvest handling processes (Grace et al., 2020).

Health Benefits of Spiced Tea

Black tea has been shown to provide many health benefits. Black tea plays an important role in protecting cell membranes from oxidative damage, repairing the microflora in the digestive tract and preventing tooth decay. In vitro studies and the use of experimental animals conducted by MacKenzie et al. (2007) showed that black tea contributes to preventing type 2 diabetes by controlling glucose levels in the blood. In addition, the polyphenol content in black tea has the main benefit as due to it's antioxidative and anti-inflammatory effects (Fatima et al., 2011). Besides the bioactive compounds that can nourish the body, black tea is able to improve our mental condition by providing positive energy and mental performance when consuming it (Das et al., 2019). However, the antioxidant capacity of black tea is low as compared to that of green tea (Bartoszek et al., 2018), and therefore adding another antioxidant resources will be an advantage.

The addition of spices with certain types and proportions to black tea can increase its functional value and provide a beneficial effect on the body. Some types of spices that are often added into black tea products are for example ginger, cinnamon, nutmeg, cardamom and cloves. Bioactive compounds in spices can improve the quality of spiced tea, both in terms of medicinal effects and sensory (Batubara and Pratiwi, 2018). Many studies have been conducted to examine the health benefits of black tea blends with various spices. Health benefits and antioxidant activity in spiced tea based on previous studies are shown in Table 2. Those studies conclude that the use of spices such as ginger, nutmeg, cinnamon (Ochanda et al., 2015a); cardamom, reed (Ekaputra and Katrim, 2013); and cloves (Das et al., 2019) or combination with tea had increased antioxidant activity. The evaluation on free radical scavenging ability is presented in either percentage of inhibition or the concentration required to scavenge 50% of the initial 2,2-diphenyl-1-picrylhydrazyl (DPPH) radicals. The study also showed that different spices may have different activity or different ability in increasing antioxidant level of the beverage. For example, cinnamon that exhibited highest antioxidant potential cinnamon (Ochanda et al., 2015a). Therefore, further research should explore the potentials of diverse spices used in tea, either added into *Camelia sinensis* true tea with many different processing types or as herbal tea mixture. This is particularly for those spices of high abundance and locally available. The next challenge is the effort to find the best optimum formula of spiced tea, which may offer both, health advantage and sensory acceptance for domestic and overseas consumers.

Table 2. Research results of health benefits and antioxidant activity in spiced tea

Product	Composition	Antioxidant Activity	Health Benefits	References
Ginger tea	5% ginger and 95% aerated black tea from TRFK 6/8 (tea cultivar from Kenya)	88.31%	Reduced blood sugars, lowered cholesterol levels, improved heart disease risk factors, and prevented carcinogenic substances.	(Ochanda et al., 2015a)
Cardamom tea	The proposition of cardamom and reed is 10:0	The IC_{50} value is 482.698 µg/ml	It can decrease high blood pressure, relieve stomach issues, detoxify, and lead to minty fresh breath due to its ability to resist common mouth bacteria.	(Ekaputra et al., 2013)
Reed tea	The proposition of reed and cardamom is 10:0	The IC_{50} value is 466.761 µg/ml	Good for digestion problems, controlling diabetes, leukemia and preventing the emergence of breast cancer	(Ekaputra et al., 2013)
Cardamom and reed tea	The best combination of the proportion of cardamom and reed is 3:7	The IC_{50} value is 385.437 µg/ml	Antioxidant source for the body, used in traditional medicine	(Ekaputra et al., 2013)
Nutmeg tea	5% nutmeg and 95% aerated black tea from TRFK 6/8 (tea cultivar from Kenya)	90.88%	Relieve the pain, strengthen cognitive function, detoxify the body, reduce insomnia, improve blood circulation and prevent leukaemia.	(Ochanda et al., 2015a)
Cinnamon tea	5% cinnamon and 95% aerated black tea from TRFK 6/8 (tea cultivar from Kenya)	91.94%	Anti-inflammatory in the respiratory tract because it has secretolytic properties, good for insomniacs, and improves insulin sensitivity which can lower blood sugar.	(Ochanda et al., 2015a)
Clove tea	The best proportion of clove and tea is 1:5	1113.44 mg AAE (Ascorbic Acid Equivalent)/cup of 100 ml tea	Helps boost metabolic rate, which further helps in weight loss, eugenol in clove helps in cleaning phlegm, fighting bacterial infection because it contains vitamin E and vitamin K and anti-cancer, and boost the immune system	(Das et al., 2019)

Conclusion

Diversification of tea (*Camellia sinensis*) products using spices or so-called spiced tea may increase the functional benefits of tea and the sensory acceptance. One of the major benefits is due to antioxidant properties from combination of tea and spices. Many locally abundant spices and/or other materials can be incorporated into *Camellia sinensis*-based tea and worth exploring. The diversification or innovation of Indonesian tea products will be important for the development of tea market and may contribute to increase tea export. It will answer global challenges not only for Indonesian tea but also Indonesian spices.

Declarations

Conflict of interests The authors declare no competing interests.

References

Abudureheman, B., Yu, X., Fang, D., and Zhang H. (2022) 'Enzymatic oxidation of tea catechins and its mechanism', *Molecules* ,27(3), pp. 1-15

Ahmad, I., Das, T. T., Yasin, M., and Hossain, M. A. (2016) 'Study on biochemical compounds, antioxidant activity and organoleptic taste of some spice tea', *Agriculture and Food Sciences Research*, 3(2), pp. 53–58

Ariviani, S., and Ishartani, D. (2009) 'Formulasi teh herba manis (teh hijau-stevia-herba): Organoleptik, antioksidan dan total kalori (Formulation of sweet herb tea (green tea-svitea-herb): Organoleptic, antioxidant and total calorie)', *Jurnal Teknologi Hasil Pertanian*, 2(2), pp. 78–86 [In Indonesian]

Asif, M. (2015) 'Chemistry and antioxidant activity of plants containing some phenolic compounds', *Chemistry International*, 1(1), pp. 35–52

Badan Pusat Statistik (BPS) (2020) *Statistik Teh Indonesia 2020 (Indonesian Tea Statistics 2020)* [Online]. Available at: https://www.bps.go.id/ (Accessed: 30 November 2021) [In Indonesian]

Badan Pusat Statistik (BPS) (2021) *Statistik Teh Indonesia 2021 (Indonesian Tea Statistics 2020)* [Online]. Available at: https://www.bps.go.id/ (Accessed: 30 November 2022) [In Indonesian]

Bartoszek, M., Polak, J., and Chorążewski, M. (2018) 'Comparison of antioxidant capacities of different types of tea using the spectroscopy methods and semi-empirical mathematical model', *European Food Research and Technology*, 244, pp. 595–601

Batubara, S. C., and Pratiwi, N. A. (2018) 'Pengembangan minuman berbasis teh dan rempah sebagai minuman fungsional (Development of tea and spice-based drinks as functional drinks)', *Jurnal Industri Kreatif Dan Kewirausahaan*, 1(2), pp. 109–123 [In Indonesian]

Bermawie, N. (2020) *Potensi Tanaman Rempah , Obat Dan Atsiri Menghadapi Masa Pandemi Covid-19* (*The Potential of Spices, Medicines and Essential Plants Facing the Covid-19 Pandemic)*. Bogor: Balai Penelitian Tanaman Rempah dan Obat [In Indonesian]

Bhandari K, Satyanarayana, S. V., De, B, Katakam, P., and Saha, G. (2019) 'Variance in antioxidant potentials and neuroprotective effect of black tea due to seasonal effect', *Indo Global Journal Pharmaceutical Sciences*, 9(1), pp. 54-59

Das, C., Kothari, S., Muhuri, A., Dutta, A., Ghosh, P., and Chatterjee, S. (2019) 'Clove based herbal tea : Development , phytochemical analysis and evaluation of antimicrobial property', *Journal of Pharmaceutical Science and Research*, 11(9), 3122–3129

De, B., Bhandari, K., and Goswami, T. K., (2019) 'Tea diversification products and value addition', *Global Journal of Pharmacy & Pharmaceutical Sciences*, 7(3), pp. 88-90

Ekaputra and Katrin, R. (2013). Uji Aktivitas Antioksidan Sediaan Teh Celup Kombinasi Rimpang Kapulaga (*Amomum cardamomum*) Dan Akar Alang- Radikal Dpph (Antioxidant activity test of the tea bags preparation of cardamom rhizome *Amomum cardamomum* and imperatae radix imperata cylindrica combination with DPPH free radical scavenging method). Thesis. Universitas Indonesia, Jakarta. [In Indonesian]

Fatima M., and Rivzi S. I. (2010) 'Health Beneficial Effects of Black Tea', *Biomedicine*, 11(3), pp. 369–373

Grace, E., Olarte-Mantilla, S. M., Sunarharum, W. B., Ong, C. M., Waanders, J., D'Arcy, B. R., and Smyth, H. E. (2020) 'Sensory properties of yellow pea and macadamia honeys from conventional and flow hive extraction methods', *Journal of the Science of Food and Agriculture*, 100(5), pp. 2027–2034

Gupta, R. K., Chawla, P., Tripathi, M., Shukla, A. K., and Pandey, A. (2014) 'Synergistic antioxidant activity of tea with ginger, black pepper and tulsi', *International Journal of Pharmacy and Pharmaceutical Sciences*, 6(5), pp. 477–479

Lumingkewas, M., Manarisip, J., Indriaty, F., Walangitan, A., Mandei, J., and Suryanto, E. (2019) 'Aktivitas antifotooksidan dan komposisi fenolik dari daun cengkeh (*Eugenia aromatic L* .)', *Chemistry Progress*, 7(2), pp. 96–105

MacKenzie, T., Leary, L., and Brooks, W. B. (2007) 'The effect of an extract of green and black tea on glucose control in adults with type 2 diabetes mellitus: double-blind randomized study', *Metabolism*, *56*(10), pp. 1340–1344

Malongane, F., McGaw, L. J., and Mudau, F. N. (2017) 'The synergistic potential of various teas, herbs and therapeutic drugs in health improvement: A review', *Journal of the Science of Food and Agriculture*, 97(14), 4679–4689

Suseno, R., Surhaini, Rahmi, S. L., and Yanti, F. (2022) 'Characteristics and sensory properties of lemongrass, roselle, and ginger formulation herbal tea', *IOP Conference Series: Earth and Environmental Science*, 951, pp. 1-8

Martono, B., and Setiyono, R. T. (2014) 'Skrining fitokimia enam genotipe teh (Phytochemical screening of six tea genotypes)', *Jurnal Tanaman Industri Dan Penyegar*, 1(2), pp. 63-68 [In Indonesian]

Muna, N., Zakiah, N., Aulianshah, V., Munira, Sari, A. (2019) 'Efek sitotoksik ekstrak buah kapulaga jawa (*Amomum compactum Soland. Ex. Maton*) (Cytotoxic effect of Cardamom Java (*Amomum compactum Soland. Ex. Maton*) Extracts)', *Jurnal*

Sago Gizi Dan Kesehatan, 1(1), pp. 79–84 [In Indonesian]

Mushtaq, S., Imtiyaz, Z., Wali, A. F., Khan, A., Rashid, S. M., Amin, I., Arafah, A. (2020) 'Honey: A powerful natural antioxidant and its possible mechanism of action' in Rehman, M. U., and Majid, S. (eds.) *Therapeutic Applications of Honey and its Phytochemicals*. Singapore: Springer, pp. 11-30

Ochanda, S. O., Wanyoko, J. K., and Ruto, H. K. (2015a) 'Antioxidant capacity and consumer acceptability of spiced black tea', *Journal of Food Research*, 4(6), pp. 104-112

Ochanda, S. O., Wanyoko, J. K., and Ruto, H. K. (2015b) 'Effect of spices on consumer acceptability of purple tea', *Food and Nutrition Sciences*, 6(8), pp. 703–711

Pebiningrum, A., and Kusnadi, J. (2018) 'Effect of ginger varieties (*Zingiberofficinale*) and addition of honey to the antioxidant activity of kombucha ginger fermented drink', *Journal of Food and Life Sciences* , 1(2), pp. 33–42

Prabowo, M. F., Bimantio, M. P., and Widyowanti, R. A. (2022) 'Formulasi teh rempah dengan penambahan pewarna alami (Herbal tea formulation with the addition of natural dyes)', *BIOFOODTECH : Journal of Bioenergy and Food Technology*, 1(1), pp. 20–39 [In Indonesian]

Prawira-Atmaja, M. I., Maulana, H., Shabri, S., Riski, G. P., Fauziah, A., Harianto, S., and Rohdiana, D. (2021) 'Evaluasi kesesuaian mutu produk teh dengan persyaratan standar nasional Indonesia (Evaluation of conformity of tea product quality with the requirements of Indonesian national standards)', *Jurnal Standardisasi*, 23(1), pp. 43–52 [In Indonesian]

Putri, E. A. M., Devi, M., and Soekopitojo, S. (2021) 'Kapasitas antioksidan teh herbal daun nangka dan rempah (The antioxidant capacity of jackfruit leaf herbal tea and spices)', *Prosiding Pendidikan Teknik Toga Busana*, 16(1), pp. 1-5 [In Indonesian]

Rohi, M., Nashine, R., and Gomashe, A. V. (2017) 'Synergic antimicrobial impacts of green tea, honey and ginger on *Pseudomonas aeruginosa* and *Staphylococcus aureus*', *International Journal Of Researches In Biosciences, Agriculture And Technology*, 2017, pp. 15-17

Ryadha, R., Nurriqqa, A., and Annisa, B. (2021) 'Potensi rempah-rempah sebagai minuman fungsional sumber antioksidan dalam menghadapi pandemi Covid-19 (The potential of spices as functional drinks as a source of antioxidants in dealing with the Covid-19 pandemic)', *Jurnal ABDI (Sosial, Budaya dan Sains)*, 3(1), pp. 30–42 [In Indonesian]

Savitri, K. A. M., Widarta, I. W. R., & Jambe, A. A. G. N. A. (2019). Pengaruh perbandingan teh hitam (*Camellia sinensis*) dan jahe merah (*Zingiber officinale var. rubrum*) terhadap karakteristik teh celup (Effect of comparison of black tea (*Camellia sinensis*) and red ginger (*Zingiber officinale var. rubrum*) on the characteristics of teabags)', *Jurnal Ilmu Dan Teknologi Pangan (ITEPA)*, 8(4), pp. 419-429 [In Indonesian]

Sayuti, K. and Yenrina, R. (2015) *Antioksidan Alami dan Sintetik* (Natural and Synthetic Antioxidants). Padang: Andalas University Press [In Indonesian]

Srinivasan, K. (2017) 'Ginger rhizomes (*Zingiber officinale*): A spice with multiple health beneficial potentials', *PharmaNutrition*, *5*(1), pp. 18–28

Sunaryo, H., Rahmania, R. A., Dwitiyanti, D., and Siska, S. (2015) 'Aktivitas antioksidan kombinasi ekstrak jahe gajah (*Zingiber officinale rosc.*) dan zink berdasarkan pengukuran MDA, SOD, dan katalase pada mencit hiperkolesterolemia dan hiperglikemia dengan penginduksi streptozotosin (Antioxidant activity of a combination of elephant ginger extract (*Zingiber officinale rosc.*) and zinc based on measurements of MDA, SOD, and catalase in hypercholesterolemia and hyperglycemia mice with streptozotocin induction)', *Jurnal Ilmu Kefarmasian Indonesia*, *13*(2), pp. 187–193 [In Indonesian]

The Ministry of Agriculture RI. (2022) *Produksi Teh Menurut Provinsi di Indonesia, 2017-2021* (*Tea Production by Province in Indonesia, 2017-2021)* [Online]. Available at: https://www.pertanian.go.id/home/index.php?show=repo&fileNum=206 (Accessed: 12 January 2020) [In Indonesian]

Toydemir, G., Capanoglu, E., Kamiloglu, S., Firatligil-Durmus, E., Sunay, A. E., Samanci, T., and Boyacioglu, D. (2015) 'Effects of honey addition on antioxidative properties of different herbal teas', *Polish Journal of Food and Nutrition Sciences*, *65*(2), pp. 127–135