ISSN: 2754-477X

Journal of Food Technology & Nutrition Sciences

SCIENTIFIC Research and Community

Research Article

Open Access

Comparative Study of Biochemical Components in Organic and Non-Organic Black Tea

Zubaer Khan, Mitu Samadder* and Yasin Anwar

Department of Food Engineering and Tea Technology, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh

ABSTRACT

During the period of 10 September 2020 to 15 September 2021, an experiment was conducted at the Department of Food Engineering and Tea Technology, Shahjalal University of Science and Technology (SUST), Sylhet, to compare the biochemical components and quality parameters of organic and non-organic black tea. The sample, consisting of two apical leaves and a bud, was taken from the KKTE (Organic) and HTE (Non-Organic) Experimental Farm in Pranchagarh, Bangladesh. Then, tea is made using the CTC method using samples. The total amount of polyphenol, moisture, dry matter, lipid, ash, caffeine, theaflavin, thearubugin, high polymerized substances, total liquor color, antioxidant activities, and water extract were measured in these samples. The sample, consisting of two apical leaves and a bud, was taken from the KKTE (Organic) and HTE (Non-Organic) Experimental Farm in Pranchagarh, Bangladesh.Then, tea is made using the CTC method using samples. The total amount of polyphenol, moisture, dry matter, lipid, ash, caffeine, theaflavin, thearubugin, high polymerized substances, total liquor color, antioxidant activities, and water extract were measured in these samples.

***Corresponding author**

Mitu Samadder, Department of Food Engineering and Tea Technology Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh.

Received: November 01, 2023; **Accepted:** November 14, 2023; **Published:** November 24, 2023

Keywords: Black Tea, Organic, Non-Organic, Biochemical Component

Introduction

Tea is a beverage made from the leaves and leaf buds of the plant Camellia sinensis, a species in the family Theaceae. With a per capita consumption of 120 ml/day, tea is the second most popular non-alcoholic beverage consumed globally after water [1]. Bangladesh's main export is tea, which brings in a lot of foreign exchange [2]. Due to the increase in domestic tea consumption and the highly competitive global market, Bangladesh is facing significant difficulties [3]. Currently, Bangladesh produces 1,89% of the tea consumed worldwide. Currently, Bangladesh produces 1,89% of the tea consumed worldwide [4]. According to, 72% of the world's total tea production is black tea. Black tea production is a challenging biochemical process. The tea shoots go through various transformations during the processing stages, beginning with the picking of young tea leaves (plucking), moving on to withering, CTC rolling, fermentation, and finally drying [5,6]. Due to their inherent antioxidant activity, polyphenols, which are chemical compounds found in the leaves and seeds of tea plants, shield the plants from oxidative damage [7]. In addition, polyphenol has a positive impact on human health. Many diseases have free radicals as their starting point. Tea contains a variety of catechines, each with a unique chemical structure that contributes to the beverage's key qualities, particularly its astringent flavor [8,9]. In enzyme-catalyzed reactions, polyphenol is oxidized to produce bright and orange-red theaflavins and brownish-red thearubigins [10,11]. Theaflavins make up between 0.3 and 0.8 percent and thearubigins between 10 and 20 percent of black tea by weight, respectively. These components are largely linked to the color and strength of liquor as well as some other characteristics of liquor [12,13]. According to; theaflavins have astringent tastes and help to give black tea its astringency and brightness [14,15]. Tea contains between 1 and 5% of its dry weight in caffeine, which makes it such a well-liked beverage. In addition to stimulating the nervous system, caffeine is a key ingredient in tea, contributing to its briskness and other flavor characteristic [16-18]. The polymer of amino acids is called protein. About 15–20% of the dry weight of tea is made up of protein, which is essential for the quality of the beverage as well as for the development of the human body [19]. The development of aroma is caused by protein and amino acids [20]. About 5 to 7% of the weight of tea leaves is made up of carbohydrates. It contributes little to nothing to the liquoring characteristics of tea, and the main ingredients are glucose, fructose, sucrose, arabinose, and ribose [21]. Lipid can make up 7 to 10 percent of the weight of tea and may or may not have a significant impact on the quality of the beverage [22]. The moisture content, which ranges from 3 to 7 percent, has a significant impact on the quality of processed tea. On a dry weight basis, the ash content was calculated to be around 4%. It shows the presence of attributes related to mineral content in tea quality and it is clear that higher values are unacceptable for good tea quality [23]. Tea plantations are grown in Bangladesh using both organic and non-organic methods. Non-organic practices are frequently used in the majority of tea gardens. Producing something organically refers to doing so without the use of artificial pesticides, chemical fertilizers, or growth regulators when growing a crop (or another agricultural product, like livestock). For nutrition and upkeep of soil fertility, naturally occurring mined products and large concentrated organic manures are used. In addition to these requirements, the growth of this plant is influenced by the soil type, environment,

pruning cycle, altitude, and manuring technique. These are the main elements that affect tea plant growth. Polyphenolic compounds, amino acids, and caffeine are the substances that contribute to the distinctive flavor of tea. Terpenoids, alcohols, carbonyl compounds, lipids, and other volatile compounds, among others, contribute to the distinctive aromas of tea (Chen and Zhou, 2005). Producing organic tea, Kazi & Kazi Tea Estate Ltd. is the only sizable garden of its kind in Bangladesh. The organic tea is offered both domestically and internationally under the Teatulia and KK Tea brands, respectively. In Panchagarh, Bangladesh's far north-west, a study is currently being conducted to compare the biochemical and quality parameters of organic and non-organic black tea. The study's goals were to compare the biochemical components and quality indicators of organic and non-organic tea, as well as to understand the concepts underlying organic and conventional methods of tea cultivation.

Materials and Methods

Between September 10, 2020, and September 13, 2021, this experiment was carried out in the lab of the Department of Food Engineering and Tea Technology at Shahjalal University of Science and Technology (SUST), Sylhet. Tea shoots with an apical bud and two leaves were plucked from gardens in Panchagarh, Bangladesh's Kazi and Kazi Tea Estate and Hoque Tea Estate Experiment Tea Garden, which are divided into KKTE (Organic) and HTE (Non Organic) sections. The green leaf samples were allowed to wither for 5 hours at room temperature (21 degrees Celsius), with a fan providing constant air supply. After being rolled for 4 hours, the withered leaves were minced/crushed using a C.T.C.-style machine. The macerates were spread out on a spotless floor and given a one-hour fermentation period at 25 degrees Celsius. Following fermentation, leaves were dried using an oven dryer at 120 degrees Celsius for one hour, and then each sample was preserved separately in an airtight plastic zipper bag to keep out microorganisms. The replication system was used to conduct the entire experiment.

Results and Discussion

The sample (apical two leaf and a bud) was collected from the experimental plot of Kazi & Kazi Tea Estate (as organic) and Haque Tea Estate (as non-organic) in Panchagarh. Then made tea is prepared by the samples by CTC method. The analysis of quality parameters of both green leaves and made tea is presented below;

Total Polyphenol, and Caffein of teas

Polyphenols are the most important tea constituents, with antioxidative, anticarcinogenic, and antiarteriosclerotic characteristics [24-26]. Depending on how the tea is harvested, handled, processed, and brewed, the polyphenol level in the tea can vary. Caffeine, which is found in tea and coffee, imparts bitterness and acts as a flavor constituent. The caffeine content of the teas is not very dispersed. Polyphenol, and Caffein found in organic tea was 51.39±0.77 ppm, and 70.35±1.70 ppm respectively, while in non-organic tea 34.64±0.49 ppm and 64.11± 0.63ppm found respectively. statistically found more phenolic acids and caffeine in a non-organic tea compared to the organic one found highest amount of polyphenol and caffeine in organic teas [23,27].

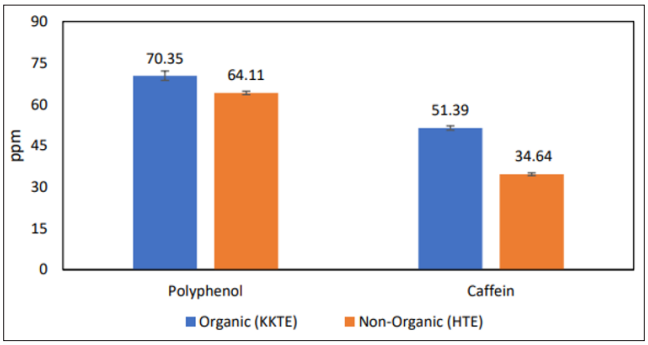

Figure 1: Graphical representation of polyphenol, caffein in Organic and Non-Organic made tea

Moisture, Water and Dry-matter Content of Organic and Non-organic Tea

Tea is produced from fresh leaves of tea plant after various tea processing procedures. Generally speaking, the tea processing procedures are always accompanied with great variations of moisture content (MC). The drying procedure dehydrates tea to reduce MC and to improve tea's smell and taste after thermo chemical reactions under high temperature. Therefore, the MC of tea not only determines the shelf life of tea, but also affects the physical and chemical reactions in tea processing, so measurement of MC is an important task for producing high-quality tea. Moisture content mainly expresses the amount of free water present in the product. In the processed tea the moisture content may be around 3-4%. It may vary with different reason.

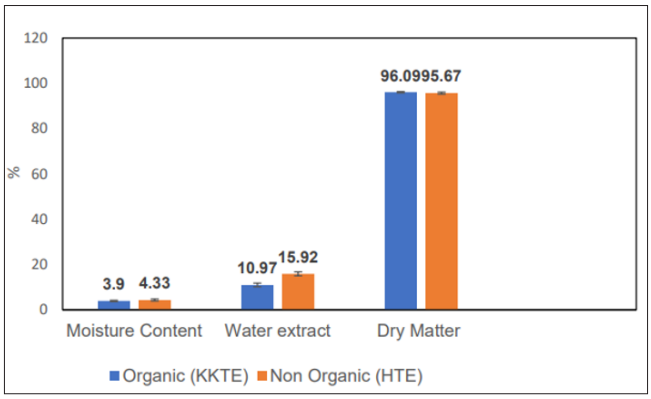

Figure 2: Moisture, Water extract and Dry-matter Content of Organic and Non-organic Tea

Lipid Content and Ash Content

Lipid emerges as an important area of biochemical study because of its being a structural and storage component of plant tissues. Neutral lipids and glycolipid and phospholipids, which constitute the lamellae fractions or other cell membranes in leaf chloroplasts, are hydrolyzed by acylhydrolases to free fatty acids [28]. Although variation in fatty acids in different molecular species could play an important role in the evaluation of cultivars with improved tea-making potential. Because of the variation in the degree of withering, type of rolling, and particle size in orthodox and CTC teas, it is expected that fatty acids would be affected differentially, hence, the flavor volatile in the end product. Lipid makes up a large portion of the fresh tea leaf but because of its low water solubility, its thoughts to be a minor portion of the extract solids. It is hypothesized that tea polyphenol and caffeine provide extra solubility for the lipid content. Tea has been used as a daily beverage and crude medicine in China for thousands of years. Tea possesses antipyretic and diuretic effects,

etc. The pharmacological effects of tea are reviewed, including antioxidative activity and antimutagenic and anticancer effects. Ash content, which represents total mineral content found high in non-organic tea. The major element in tea minerals is potassium which is half the total mineral content. Thus, the soluble ash obtained from spent tea will have lower alkalinity value and the ash itself is high in calcium [29,30].

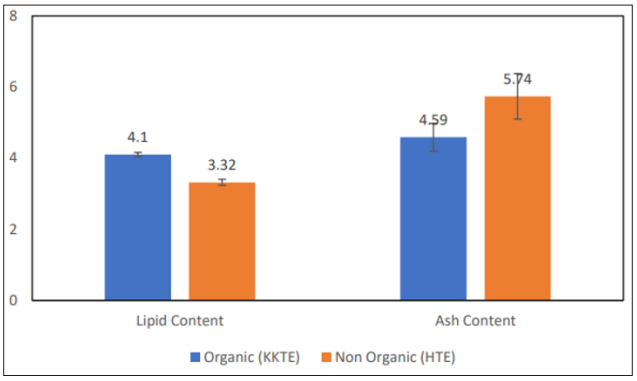

Figure 3: Lipid Content and Ash Content of Organic and Non-organic Tea

Theaflavin (TF), Thearubigin (TR), highly polymerized substances (HPS) and total liquor color (TLC)

TF, TR, HPS, TLC content was analyzed with the help of Black tea manufactured from infested leaves and Fresh leaves (Table1).

Table 1: TR, TF, HPS, and TLC content in made tea of Organic and Non-Organic

Parameters	TF(%)	TR(%)	TF: TR	HPS(%)	TLC(%)
Organic (KKTE)	0.78± 0.28	8.36 ± 0.97	1:9.233	4.25± 0.38	2.04 ± 0.07
Non-Organic (HTE)	0.63 ± 0.45	5.86 ± 0.73	1:6	7.02 ± 0.14	2.87± 0.12

Results indicated that TF content highest in organic tea.TR content is highest in Organic tea and lowest in non-organic tea. The TF:TR ratio of Organic (1:9.22) is near about to standard ratio (1:10) and this ratio is very important for good quality tea. Among the samples organic tea showed the highest total liquor colour. The reason might be the higher amount of TF & TR content in it as they are responsible for briskness & brightness and colour & strength respectively (Obanda et al. 2001)[14]. As the TF:TR in matured tea close enough to standard ratio, the depth as well as the strength and mouthfeel of the tea liquor will be pleasant/satisfactory in it [11,13]. It is evident that Darjeeling tea possesses a good amount of TF and this might be the reason for which the liquor brightness as well as briskness of it is higher.

Antioxidant activities

DPPH is a useful reagent for investigating the free radical-scavenging activities of compounds. In the DPPH test, the extracts were able to reduce the stable radical DPPH to the yellow colored diphenyl hydrazine. The method is based on the reduction of alcoholic DPPH solution in the presence of a hydrogen-donating antioxidant due to the formation of the non-radical form DPPHH by the reaction.

From the assembly, the scavenging effect at different concentration shows that, the KKTE (Organic) tea sample is the highest scavenger of free radical every time. But the antioxidant activities of both sample antioxidant activities were in satisfactory level. Concerning the antioxidative and anticarcinogenic effects of tea, reported that green tea antioxidant had antioxidative activity toward hydrogen peroxide and superoxide and that prevented oxygen radical and hydrogen peroxide induced cytotoxicity and inhibition of intercellular communication in cell culture [31]. The addition of antioxidants to food is an effective way to prevent the development of various off-flavors and undesirable compounds that result from lipid oxidation. The possible toxicity, as well as general consumer rejection, led to the decreasing use of synthetic antioxidants. Crude and refined rosemary extracts, which are used as natural antioxidants, are now commercially available. It was found that approximately 90% of the antioxidant activity of rosemary can be attributed to carnosol and carnosic acid [32]. These two compounds also showed strong antioxidant activity and soybean lipoxygenase inhibition ability as well as peroxyl radical, H, O and HOCI scavenging activities [32]. Antioxidant activities are found to be higher than the non-organic one [33,34].

Table 2: Scavenging effect of different tea samples

Sample	Scavenging effect (%)		
	0.2 mg/ml (sample)	0.4 mg/ml (sample)	0.6 mg/ml (sample)
KKTE (Organic)	95.96 ± 0.853	95.15 ± 0.220	96.9 ± 0.601
HTE (Non-Organic)	92.89 ± 0.732	93.16 ± 0.240	94.24 ± 0.879

Conclusion

The present Study has covered all aspects of biochemical and quality parameters of Organic and Non-Organic black tea. Tea is a good source of antioxidant, theaflavin, thearubigin, caffeine, and these have a great influence on the human health because of their medicinal properties. For this study it was observed total polyphenol is more in the leaf of KKTE (Organic) 52.11±0.69 ppm and lower in the HTE (Non Organic) leaf 23.09±0.2.14. Lipid content is low in HTE and high in KKTE. Caffeine is high in KKTE (Organic) tea 68.19±4.48 and low in HTE (Non-Organic) tea 49.70±2.62. The leaf of KKTE (Organic) shows the best TF, TR content and TF: TR ratio. The antioxidant activities of KKTE (Organic) tea high above 95% in every concentration of sample. Whereas the HTE (Non Organic) is the inferior type of tea with lower amount lipid, caffeine, polyphenol, and antioxidant than that of organic tea. The experiment shows the KKTE (Organic) tea contain the high amount of polyphenol, caffeine, antioxidant, total lipid. From the above result, the tea of KKTE (Organic) can be referred as the best quality tea with health benefit and high refreshing activities.

References

1. McKay DL, Blumberg JB (2002) The role of tea in human health: An update. Journal of the American College of Nutrition 21: 1-13.
2. Rahman MZ (2018) "Assessment of socio-economic and sexual vulnerability of tea workers in Bangladesh." 4: 229-240.
3. Nasir T (2011) "Tea productions, consumptions and exports: Bangladesh perspective." 2: 68-73.
4. Saha Jiban, Adnan KM, Sarker Swati, Bunerjee Shefali (2021) Analysis of Growth Trends in Area, Production and Yield of Tea in Bangladesh. Journal of Agriculture and Food Research http://dx.doi.org/10.1016/j.jafr.2021.100136.
5. Sharangi AJ (2009) "Medicinal and therapeutic potentialities of tea (Camellia sinensis L.)–A review." 42: 529-535.
6. KR Jolvis Pou, Sanjib K Paul, Santanu Malakar (2019) Industrial Processing of CTC Black Tea, Caffeinated and

Cocoa Based Beverages,Woodhead Publishing 131-162.
7. Fukushima Y, Ohie T, Yonekawa Y, Yonemoto K, Aizawa H, et al. (2009) Coffee and green tea as a large source of antioxidant polyphenols in the Japanese population. J Agric Food Chem 57: 1253-1259.
8. Santanu Sabhapondit, Tanmoy Karak, Lakshi Prasad Bhuyan, Bhabesh Chandra Goswami, Mridul Hazarika (2012) Diversity of catechin in northeast Indian tea cultivars. The Scientific World Journal 485193.
9. Ding Z, Kuhr S, Engelhardt UH (1992) Influence of catechins and theaflavins on the astringent taste of black tea brews. Zeitschrift f??r Lebensmittel-Untersuchung und - Forschung 195: 108-111.
10. Brown AG, Eyton WB, Holmes A (1969) The identification of the thearubigins as polymeric proanthocyanidins. Phytochemistry 8: 2333-2340.
11. Robert EAH, Smith RF (1960) Spectrophotometric Measurements of Theaf lavins and Thearubigins in Black Tea Liquors in Assessments of Quality in Teas. Analyst 86: 94-98.
12. Geissman TA (1962) The chemistry of flavonoid compounds. Oxford, London, New York, Paris.: Pergamon Press https://search.worldcat.org/title/chemistry-of-flavonoid-compounds/oclc/3045238.
13. Roberts EAH (1958) The chemistry of tea manufacture. Journal of the Science of Food and Agriculture 9: 381-390.
14. 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: 395-404.
15. Deb SB, Ullah MR (1968) The role of theaflavins and thearubigins in the evaluation of black tea. Two and a Bud 15: 101-102.
16. Hilton PJ, Ellis RT (1972) Estimation of the market value of Central African tea by theaflavin analysis. Journal of the Science of Food and Agriculture 23: 227-232.
17. Khokhar S, Magnusdottir SGM (2002) Total phenol, catechin, and caffeine contents of teas commonly consumed in the United Kingdom. Journal of Agricultural and Food Chemistry, 50: 565-570.
18. Perva-Uzunalic A, Skerget M, Knez Z, Weinreich B, Otto F (2006) Extraction of active ingredients from green tea (Camellia sinensis): Extraction efficiency of major catechins and caffeine. Food Chemistry 96: 597-605.
19. Cabrera C, Artacho R, Giménez R (2006) Beneficial effects of green tea--a review. Journal of the American College of Nutrition 25: 79-99.
20. Eden T (1960) The development of tea culture. In: Tea. (Ed. Eden) Longman. London 1-4.
21. Roberts-theogallin C (1954) Theogallin Polyphenol OccurringInTea_ARC artwright.pdf 593-597.
22. Hara Y, Luo SJ, Wickremasinghe RL, Yamanishi T (1995) Special issue on tea. Food Res. Int 11: 371-545.
23. Rahman M (2012) "Change of chemical compositions in semi-fermented tea on land elevation." 41: 11-16.
24. Atoui Ali, Mansouri Abdelhak, Boskou George, Kefalas Panagiotis (2005) Tea and herbal infusions: Their antioxidant activity and phenolic profile. Food Chemistry 89: 27-36.
25. Dufresne CJ, Farnworth ER (2001) A Review of Latest Research Findings on the Health Promotion Properties of Tea. The Journal of Nutritional Biochemistry 12: 404-421.
26. Wang Huafu, Helliwell Keith (2001) Determination of flavonols in green and black tea leaves and green tea infusion by high-performance liquid chromatography. Food Research International 34: 223-227.
27. Kazimierczak R, Hallmann E, Rusaczonek A, Rembiałkowska E (2015) Polyphenols, tannins and caffeine content and antioxidant activity of green teas coming from organic and non-organic production. Renewable Agriculture and Food Systems 30: 263-269.
28. Wright AJ, Fishwick MJ (1979) Lipid degradation during manufacture of black tea. Phytochem 18: 1511-1513.
29. Satoshi S, Hara Y (1990) Antioxidative activity of tea catechins. Fragrance J 24-30.
30. Tsuneo Kada, Kenji Kaneko, Satoshi Matsuzaki, Taeko Matsuzaki, Yukihiko Hora (1985) Detection and chemical identification of natural bio-antimutagens: A case of the green tea factor, Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis 150: 127-132.
31. Ruch RJ, Cheng SJ, Klaunig JE (1989) Prevention of cytotoxicity and inhibition of intracellular communication by antioxidant catechins isolated from Chinese green tea. Carcinogenesis 10: 1003-1008.
32. Okezie I Aruoma, Jeremy PE Spencer, Donna Warren, Peter Jenner, John Butler, et al. (1997) Characterization of food antioxidants, illustrated using commercial garlic and ginger preparations. Food Chemistry 60: 149-156.
33. Hilton PJ, Ellis RT (1972) Estimation of the market value of Central African tea by theaflavin analysis. Journal of the Science of Food and Agriculture 23: 227-232.
34. AACC, Approved methods of the American association of cereal chemists 10th ed.: American Association of Cereal Chemists, St. Paul, MN, 2000. https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1488371.