Effect of Sencha (Green Tea) and Silver Needle (White Tea) Addition on the Antioxidant Activity of Probiotic Yogurt

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Abstract—In this study, antioxidants were extracted from two different types of tea, green tea (Sencha) and white tea (Silver Needle) by using infusion extraction method. The extracted antioxidants were tested with self-made yogurt. The main objectives of this study were to analyze the total phenolic content of the extracted antioxidants from two different types of teas and to observe the shelf life of the self-made yogurt mix when added with the extracted antioxidant. The extracted antioxidants (natural antioxidant) were also compared with the synthetic antioxidant, butylated hydroxyanisole (BHA). In TPC test, the synthetic antioxidant, BHA extract (10103 µg GAE/g ± 0.006403) has the highest content of polyphenol followed by Sencha (8636 µg GAE/g ± 0.03607) and Silver Needle (5787 µg GAE/g ± 0.02759) teas extracts. In DPPH test, the scavenging activity of BHA extract (97.37 % ± 0.001414) was shown the highest values compare to the Sencha (94.03 % ± 0.001414) and Silver Needle (89.78 % ± 0.0389) tea extracts. After the characterization, the extracted antioxidants from Sencha, Silver Needle teas and synthetic antioxidant were incorporated in yogurt as preservatives. The yogurt samples with extracted and synthetic antioxidants were undergone another chemical analysis of yogurt’s lipid which were PV and AOA test. Based on AOA method, the overall of the BHA applied in self-made yogurt shown the highest antioxidant activity value followed by Sencha tea and Silver Needle tea extracts. By using PV method, BHA antioxidant shown the lowest peroxide value followed by Sencha tea and Silver Needle tea extracts. In conclusion, Sencha, Silver Needle teas and BHA were successfully employed to enhance the antioxidant properties of yogurt and provide sustained antioxidants during 28 days of storage.

Keywords— Antioxidant activity, BHA, Tea, Total phenolic content, Yogurt

I. INTRODUCTION

Synthetic antioxidants were first applied into packaged foods in the 1940s. In the beginning, they were primarily put into the fat-containing foods and edible fats for their ability to avoid food from becoming rancid and developing unpleasant odours. As far as healthy nutrition goes, aesthetically pleasing food does not necessarily imply that the food was “good for you”. Even though based on the theory it may be convenient to have access to products that have a long-term shelf-life, it was also be understood that naturally grown foods were not grown to “last forever” or look identical [1]. Antioxidants played a vital role in overall health. The most effective antioxidant sources are vegetables and fruits, as well as products derived from plants [2]. They’re also found in green tea, white tea, black tea, dark chocolate and red wine. Normally, the presence of colour indicates there was a specific antioxidant in that food. Antioxidants can be added in food as effective as those that exist naturally. For instance, vitamins such as A, C and E was added to foods, such as in orange juice. There was no significant physiological difference between the antioxidant that exist naturally and the added antioxidants in the food source [3]. Tea was a common beverage consumed by pouring boiling or hot water over cured leaves of the Camellia sinensis, an evergreen shrub native to worldwide. All camellia tea plant was wealth in polyphenols, which was one type of antioxidant [4]. These miracle nutrients scavenge for cell-damaging free radicals in the body and detoxify them. Therefore, it was significant to establish the differences in the types of tea employed on the results of the changes of antioxidant activity in yogurt and the microbial metabolism [5]. The addition of
different types of tea extracts into yogurt may enhance the antioxidant activity of yogurt. Yogurt was a coagulated milk product gained from fermentation process conducted by the incorporated activity of two lactic acid bacteria, Lactobacillus delberegkii subsp. bulgaricus and Streptococcus thermophilus [5]. Yogurt was a wealthy origin of bioactive peptides that constituted during antioxidant activity and have fermentation process. The high oxidative stability of yogurt was related with antioxidant peptides released during the fermentation of milk by lactic acid bacteria [6]. The addition of 4% whey protein concentrate in yogurt was discovered to enhance the DPPH scavenging activity, hydrogen peroxide (H$_2$O$_2$) scavenging activity and Fe$^{3+}$ chelating activity [7]. Thus, this study was conducted to extract the antioxidant from green tea (Sencha) and white tea (Silver Needle) at optimum temperature. The total phenolic content and antioxidant activity from both of the tea and synthetic antioxidant were compared. The synthetic antioxidant and extracted tea were added to self-made yogurt and the antioxidant activities were recorded.

Sencha tea is one type of green tea. The tea is widely consumed in the worldwide after the water [8]. The scientific name of this tea is Thea sinensis and also known as Camellia sinensis. The tea family was called Theaceae [9]. The slight alteration in the cultivation of tea, the different locations and climate changes for tea growth and other factors were resulted in the existence of various types of green tea. There were plentiful green tea vitamins in Sencha tea such as polyphenols catechins that act as antioxidants which contribute to human health [10]. There were also some important components of Sencha tea, which consists of caffeine, tannin, vitamin C, carbohydrates, and proteins. Theanine (amino acid) also was an important component for Sencha tea [11]. The theanine (amino acid) could found from the other various types of the green tea and it is the source of the aroma and flavour of the tea. Silver Needle tea is one type of white tea. There are the same types of antioxidants exist in white and green teas. However white tea with young tea leaves or buds contains greater amounts of antioxidants compare with the mature green tea leaves [9]. The antioxidant in white tea had many profits in health such as to lower down the cholesterol, promoting cardiovascular health, decrease the cancer rate and helps to reduce weight loss.

II. METHODOLOGY

Firstly, antioxidants were extracted from green tea (Sencha) and white tea (Silver Needle) by using the infusion extraction method followed by the antioxidant characterization. There were two tests that conducted on the antioxidant content from green tea and white tea incorporated with yogurt, which were TPC (Total Phenolic Content) test and DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging assay. Then, the antioxidant was undergo chemical and physical analysis for the application of antioxidant in yogurt which were PV ( Peroxide value) test and AOA (Antioxidant activity).

A. Preparation of Tea Water Extract

The raw materials in the preparation of tea water extract by infusion extraction method were green tea (Sencha), white tea (Silver Needle) and Butylated hydroxyanisole (BHA). There were 2% (w/v) of the tea infusions were employed for analysis. Hot water (100ml) was boiled at two different temperatures, which were 80°C and 100°C at optimum temperature from previous research and poured into each beaker containing 2 gram of Sencha and Silver Needle teas respectively. Then, the aluminium foil was used to cover the beaker and the teas were left to brew for within 2 hours for Silver Needle and 5 minutes for Sencha teas and BHA as optimum time from the previous research [12]; [5]. Next, the filtration process was conducted where the brewed teas were filtered by the tea strainer and were cooled at ambient temperature. The tea water extracts were centrifuged for 10 minutes. Finally, refrigerate the harvested supernatants at 4°C and it was used for further analysis within one to two weeks of preparation [5]. The following steps were repeated for synthetic antioxidant (BHA) extraction by using 72% of ethanol at room temperature.

B. Preparation of Yogurt

The raw materials that used in the preparation of yogurt were Sencha tea, Silver Needle tea, pasteurized whole milk (Dutch Lady) and yogurt starter culture. Green tea and white tea yogurts were prepared based on the method with slightly modification [13]. Firstly, warmed 100ml of pasteurized whole milk at 85°C and mixed with 2% (w/v) of white and green teas (2g / 100ml) and BHA relevant to the strength of “normal cup of tea” [14]; [5]. Next, the teas were infused into the milk about 10 minutes followed by the filtration process which using the fine tea strainer to get rid of the visible particles. 90ml of tea-milk infusions then be aliquoted to the sterile disposable plastic containers and were incubated at 37°C. Next, 10ml of starter culture were added into the milk-tea infusion. The step for 1% (w/v) and 0.02% (w/v) of white and green teas, synthetic antioxidant, BHA and plain yogurt were repeated as previously described without tea (control). The milk-tea infuse and all the inoculated milk were put into an incubator at 42°C while the pH
values reached 4.5 [15]. The yogurts were then refrigerated at 4°C up to 28 days.

C. Preparation of Yogurt Water Extract

The raw materials used in the preparation of yogurt water extract were green tea (Sencha), white tea (Silver Needle), and yogurt. The water extraction of yogurt was carried out as described by Baba and Shori (2013) [15]. The chemical reagents used to conduct the method were hydrochloric acid, HCl (0.1M), sodium hydroxide, NaOH (0.1M). The 10g tea and plain yogurts were weighed into the plastic centrifuge tubes. Next, the yogurts were homogenized for 10 seconds with sterile 2.5 ml of distilled water. pH meter was used to measure the pH of yogurts and 0.1M HCl was added for pH adjustment until the pH turned to 4.0. Then, the acidified yogurt was incubated and put in a water bath for 10 minutes at 45°C and the centrifugation process continued for 10 minutes. The supernatants were adjusted the pH to 7.0 by using 0.1M of NaOH followed by the another centrifugation process for 10 minutes. The clear supernatants obtained were stored in refrigerator (-20°C) and were utilized for analysis within one to two weeks of preparation [5].

D. Determination of total phenolic content (TPC)

The chemical reagents used to conduct this experiment were 2M Folin-Ciocalteu reagent, BHA and sodium carbonate, Na2CO3. The TPC assay was conducted based on the procedure depicted by Najgebauer-Lejko, et al., (2011) [12]. Mixed the 2M Folin-Ciocalteu reagent (0.5 ml) and distilled water (7.9 ml) with the gallic acid as a standard (100 µl) or samples of tea extracts. The mixture solutions then were left at room temperature about 5 minutes after the mixing process. Next, add 1.5ml of Na2CO3 solution into the mixture and stirred until it homogenized. Then, put the mixture under incubation in a dark place for 2 hours at room temperature [5]. Then, measured the solution at 765 nm absorbance in 1 cm cuvettes by using UV-Vis spectrophotometer. The readings obtained were converted to TPC utilizing the calibration curve of gallic acid. The calibration curves were constructed using several concentrations of gallic acid (10-60 mg/g) in ethanol (95%). Finally, the absorbance values were expressed as mg GAE/ml (mg gallic acid equivalent per milliliter) [5].

E. 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay

In this study, DPPH radical scavenging assay was conducted based on the method with slightly modified and it is described by Najgebauer-Lejko, et al. (2011) [12]. 0.1 mM DPPH reagent was prepared by using (1L of methanol adding into 39.4mg of DPPH). Then the tea extracts (100µl) were mixed with the 3.0ml of 0.1mM DPPH reagent. The mixture solution were stirred and left in the dark place for 2 hours at room temperature. Next, the measurement of absorbance at 515 nm was read in 1 cm cuvettes by using UV-Vis spectrophotometer (Hach, DR6000). The mixture of DPPH reagent and methanol was used as a control sample. Next, the scavenging activity of radical was calculated by using formula as shown in equation (1) [5].

$$\text{Scavenging activity (\%)} = 1 - \left[ \frac{Abs_{\text{sample}}}{Abs_{\text{control}}} \right] \times 100\%$$  

F. Antioxidant activity (AOA) test

Antioxidant activity (AOA) test method was similar like the TPC assay and DPPH method. The only difference was only the DPPH method used to test on lipids of yogurt, where the AOA test was expressed by using equation (2) [16].

$$AOA = \frac{D_{\text{control}} - D_{\text{sample}}}{D_{\text{control}}} \times 100$$

(2)

Where, Dcontrol is degradation rate of control, and Dsample is degradation rate of sample.

G. Peroxide Value (PV) Test

The chemical that used in the PV test were BHA, 320ml chloroform, 0.01N sodium thiosulfate solution, 480ml acetic acid, saturated potassium iodide solution, 1% starch solution and distilled water. Firstly, the 5g of yogurt and chloroform solution was put into a 250ml glass stoppered Erlenmeyer flask. 30ml of the acetic acid was then measured by using measuring cylinder and added into the chloroform solution. Then, the flask was warmed carefully on the hotplate and swirled the flask until the sample was completely dissolved. 0.5ml of saturated potassium iodide solution was added into the mixture by using 1ml of Mohr pipette. Next, the flask was covered with a stopper and swirl the mixture of the flask for exactly one minute [17].

30ml of distilled water was immediately added into the flask by using measuring cylinder, then stopper the flask again and shake vigorously to liberate the iodine from the chloroform layer. Afterward, the burette was filled with 0.1N sodium thiosulfate. The flask was titrated slowly until the colour change from deep red orange to light amber colour.

When the solution turned to a light amber colour, it could proceed to the following step. Add 1ml of starch solution as an indicator. Next, the solution was titrated until the blue grey colour disappears in the aqueous (upper layer). For Doe-120, titrate until the lower layer has a milky appearance. Finally, the ml of titrate used to one decimal places were accurately recorded and calculated the result using equation (3) [17].
Peroxide Value = \frac{(S - B) \times N_{thiosulphate} \times 1000}{\text{weight of sample}} \\
(3)

Where, \( S \) is titration of sample, and \( B \) is titration of blank.

III. RESULTS AND DISCUSSIONS

A. Total Phenolic Content (TPC) test

The TPC reading in water extracts of green tea (Sencha Tea) and white tea (Silver Needle Tea) and in ethanol extracts of BHA, synthetic antioxidant were summarized in Table I.

<table>
<thead>
<tr>
<th>Extract</th>
<th>TPC (µg GAE/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sencha Tea</td>
<td>8636 ± 0.03607</td>
</tr>
<tr>
<td>Silver Needle Tea</td>
<td>5787 ± 0.02759</td>
</tr>
<tr>
<td>BHA</td>
<td>10103 ± 0.006403</td>
</tr>
</tbody>
</table>

Based on the present results, synthetic antioxidant (BHA) showed the highest phenolic content (10103 ± 0.006403 µg GAE/g) followed by green tea (Sencha Tea) extracts (8636 ± 0.03607 µg GAE/g) and white tea (Silver Needle Tea) extract (5787 ± 0.02759 µg GAE/g). The synthetic antioxidant (BHA) shown the highest phenolic content compare with the other two due to the use of aqueous solvent (72% of ethanol) during the extraction process. The synthetic antioxidant (BHA) was insoluble in water, and only soluble in methanol, ethanol, propylene glycol, oils and fats. Therefore, the aqueous solvent (72% of ethanol) was used for the extraction of synthetic antioxidant (BHA).

Based on the theory, the yield of pure solvent extract is slightly higher than the water extract, but, the yield of pure solvent extract is lower than the yield of aqueous solvent extract [18]. This is because of the compounds other than phenolics would be extracted and contribute to higher yield. This gives attributable to the content of more nonphenol compounds such as higher solubility of carbohydrates and proteins in pure solvent and water extracts than in other extracts [19]. The combination of organic solvent and water would facilitate the extraction of chemicals that are soluble in organic solvent or water. It may also due to the possible complex formation of some phenolic compounds in the extract that are soluble in ethanol. These phenolic compounds would be possessed more phenol groups or higher molecular weight than the phenolics in the water extract and increase the extraction efficiency [18]. As a result, the TPC of BHA by using aqueous ethanol extract was higher than the TPC of Sencha and Silver Needle teas by using water and pure solvent extracts.

The TPC of green tea (Sencha Tea) extract shown higher than the TPC of white tea (Silver Needle Tea) extract which may be due to the abundant presence of epicatechin and catechin in green tea. The phenolic composition of green tea and white tea are remarkably same with some exceptions to flavonol glycoside compositions as reported in earlier studies [20]. In the previous study, the results showed that flavonol glycosides such as rutinoside or quercetin-rhamnosyl galactoside and kaempferol-3-rutinoside were present in white tea but absent in green tea. On the other hand, catechin derivatives such as epigallocatechin (EGC) and gallocatechin (GC) were not detected in white tea but were present in green tea. In spite of having a lot of physiological roles in plant survival including disease resistance, ultraviolet B protection and defense against predation, the contents of these flavonoids compounds in plants will reduce as plant matures. It explain the differences in phenolic compound observed between green tea and white tea [21]. Besides that, the binding capacity between the protein and tea polyphenols increases as the number of hydroxyl (OH) groups increase in phenolic compounds in the sequence of C~EC > EGC > EGCG [22]. Hence, the TPC of green tea extract was higher than the TPC of white tea extract.

Extraction of phenolic compounds of plant materials are depends on many factors such as particle size, extraction method, sample storage conditions, phenolic compounds structure and presence of other compounds. Besides, the structure of phenolic changes from simple ones to polymerize, but they can be bonded with proteins, carbohydrates and other compounds of plant material. The structure of phenolic are complexes and with high molecular mass can be insoluble which cause the extraction from the plant material very difficult [23]. Considering all above, extracted phenolics of some plant materials were the mixture of different types of phenolics, which were soluble in used extraction solvent.

Phenolic compounds serve as antioxidants through their ability to donate electron or hydrogen which resulted in the termination of a chain reaction or by chelating transition metal ions thus, terminating the Fenton reaction [24]. Phenolics were also the primary antioxidant components, and their total contents were directly proportional to their antioxidant activity [25].

B. 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay

The scavenging activity in water extracts of green tea (Sencha Tea), white tea (Silver Needle Tea) and in ethanol extracts of synthetic antioxidant (BHA) is summarized in Table II. A graph of scavenging activity against types of samples was plotted as shown in Fig. 1.
TABLE II.  SCAVENGING ACTIVITY OF TEA EXTRACTS AND BHA EXTRACT

<table>
<thead>
<tr>
<th>Extract</th>
<th>Scavenging Activity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sencha Tea</td>
<td>94.03 ± 0.001414</td>
</tr>
<tr>
<td>Silver Needle Tea</td>
<td>89.78 ± 0.0389</td>
</tr>
<tr>
<td>BHA</td>
<td>97.37 ± 0.001414</td>
</tr>
</tbody>
</table>

![Graph showing scavenging activity against types of samples](image)

Based on the graph, synthetic antioxidant (BHA) showed the highest scavenging activity (97.37 ± 0.001414 %) followed by green tea (Sencha Tea) extracts (94.03 ± 0.001414 %) and white tea (Silver Needle Tea) extract (89.78 ± 0.0389 %).

For the determination of free radical scavenging activity of antioxidant, the DPPH method was usually been used. DPPH was a very stable organic free radical and presents the capability of accepting a hydrogen radical and an electron. Based on the present result, the synthetic antioxidant (BHA) shown the highest scavenging activity compared with the other two due to the aqueous solvent (72% of ethanol) used during the extraction which has the same reasons in the analysis of TPC test. This was due to aqueous ethanol that was a good solvent for extraction and gave stronger radical scavenging capacity than that in water extract [18]. These results suggested that the 72% ethanol was a good solvent for highest scavenging activity on DPPH radicals.

This result also shows the scavenging activity of green tea (Sencha Tea) extract was higher than the scavenging activity of white tea (Silver Needle Tea). This is because the green tea has antioxidant activity primarily attributed to catechins, while white tea is dependent on quercetin [26]. Based on theory, the effectiveness of the flavonoids would be classified in order of catechin > quercetin > diosmetin [27]. The higher level of flavonoids also displayed the high total antioxidant activity [28]. Therefore, the scavenging activity of green tea extract was higher than the scavenging activity of white tea extract.

C. Antioxidant Activity (AOA) test

The extracted antioxidants from Sencha and Silver Needle teas and synthetic antioxidant (BHA) were incorporated in self-made yogurt as preservation. The self-made yogurts were prepared in four types. Firstly, the self-made yogurt were made without antioxidant as a controlled. The self-made yogurt was then followed by extracted and synthetic antioxidants addition with percentage of 0.02%, 1% and 2% for further analysis in 28 days.

TABLE III.  AOA VALUE OF TEA AND BHA EXTRACT AFTER APPLY IN SELF-MADE YOGURT

<table>
<thead>
<tr>
<th>Antioxidants</th>
<th>Percent (%)</th>
<th>Day 1</th>
<th>Day 7</th>
<th>Day 18</th>
<th>Day 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>BHA</td>
<td>0.02</td>
<td>35.62 ± 0.0028</td>
<td>54.14 ± 0.0014</td>
<td>33.33 ± 0.00028</td>
<td>28.99 ± 0.0028</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>80.03 ± 0.0076</td>
<td>55.59 ± 0.0028</td>
<td>53.73 ± 0.0046</td>
<td>52.35 ± 0.0070</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>81.22 ± 0.0028</td>
<td>80.36 ± 0.0056</td>
<td>77.00 ± 0.0028</td>
<td>70.40 ± 0.0056</td>
</tr>
<tr>
<td>Sencha Tea</td>
<td>0.02</td>
<td>17.44 ± 0.015</td>
<td>16.49 ± 0.0070</td>
<td>14.78 ± 0.16</td>
<td>13.91 ± 0.056</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>30.25 ± 0.0014</td>
<td>27.84 ± 0.0014</td>
<td>24.37 ± 0.1513</td>
<td>22.87 ± 0.0070</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>61.10 ± 0.0014</td>
<td>58.20 ± 0.0014</td>
<td>56.19 ± 0.00028</td>
<td>44.50 ± 0.0014</td>
</tr>
<tr>
<td>Silver Needle Tea</td>
<td></td>
<td>43.52 ± 0.0042</td>
<td>40.00 ± 0.0015</td>
<td>38.95 ± 0.00042</td>
<td>31.64 ± 0.0014</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>83.90 ± 0.0056</td>
<td>67.12 ± 0.029</td>
<td>66.53 ± 0.0028</td>
<td>58.84 ± 0.0056</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>88.52 ± 0.0014</td>
<td>86.49 ± 0.0012</td>
<td>80.36 ± 0.0084</td>
<td>74.72 ± 0.0042</td>
</tr>
</tbody>
</table>

Table III shows day 1, 7, 18 and 28 results of antioxidant activity for three types of yogurt samples with the different percentages of antioxidants. Based on the results, the 2.0% of extracted and synthetic antioxidant applied in the self-made yogurt shown the highest antioxidant activity followed by 1.0% and 0.02% of extracted and synthetic antioxidant. For example, in 2.0% of synthetic antioxidant (BHA) applied in self-made yogurt, the antioxidant activity value was 88.52 ± 0.001414 %. For 1.0% of synthetic antioxidant (BHA) applied in self-made yogurt, the antioxidant activity value was 83.90 ± 0.005657 % and for 0.02% of synthetic antioxidant (BHA) applied in self-made yogurt, the antioxidant activity value was 43.52 ± 0.004243 %. This is because the higher percentage of extracted antioxidant applied into the self-made yogurt, the higher antioxidant activity value were obtained and detected from the self-made yogurt.

From the result, the synthetic antioxidant (BHA) that applied in self-made yogurt was shown the highest antioxidant activity value followed by green tea (Sencha Tea) and white tea (Silver Needle Tea) extracts. The antioxidant activity of green tea and white tea extracts were lower than the synthetic antioxidant activity due to the milk-polyphenol interaction that cause to a decrease in antioxidant activity [29]. Based on the theory given, the milk-polyphenol interaction which is generally in proline plenty milk proteins (casein) because of the strong affinity of the proline groups towards to the hydroxyl (OH) groups present in the phenolic compounds [29]. This resulted in the...
precipitation of the phenolic compound and can decrease the antioxidant activity [30].

These results show self-fidelity of synthetic antioxidant applied, the antioxidant activity in the self-made yogurt shown the lowest peroxide value followed by 1.0% and 0.02% of extracted and synthetic antioxidant.

**D. Peroxide Value (PV) Test**

Table IV shows the day 1, 7, 18 and day 28 results of peroxide value for three types of yogurt samples with the different percentages of antioxidants. Based on the results, the 2.0% of extracted and synthetic antioxidant applied in the self-made yogurt shown the lowest peroxide value followed by 1.0% and 0.02% of extracted and synthetic antioxidant.

**TABLE IV. PV VALUE OF TEA AND BHA EXTRACT AFTER APPLY IN SELF-MADE YOGURT.**

<table>
<thead>
<tr>
<th>Antioxidant</th>
<th>Percentage (%)</th>
<th>PV Value (meq/kg)</th>
<th>Day 1</th>
<th>Day 7</th>
<th>Day 18</th>
<th>Day 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.0</td>
<td>3.6 ± 0.2828</td>
<td>5.4 ± 0.1414</td>
<td>8.8 ± 0.4243</td>
<td>15.4 ± 0.4243</td>
<td></td>
</tr>
<tr>
<td>Sencha Tea</td>
<td>0.02</td>
<td>2.4 ± 0.2828</td>
<td>3.8 ± 0.4243</td>
<td>9.4 ± 0.7071</td>
<td>7.6 ± 0.1414</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>2.0 ± 0.2828</td>
<td>3.4 ± 0.2828</td>
<td>9.0 ± 0.2828</td>
<td>7.0 ± 0.5657</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.6 ± 0.2828</td>
<td>2.8 ± 0.4243</td>
<td>8.6 ± 0.7071</td>
<td>6.6 ± 0.1414</td>
<td></td>
</tr>
<tr>
<td>Silver Needle Tea</td>
<td>0.02</td>
<td>2.8 ± 0.5657</td>
<td>4.2 ± 0.1414</td>
<td>10.4 ± 0.4243</td>
<td>7.8 ± 0.5657</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>2.2 ± 0.2828</td>
<td>3.8 ± 0.2828</td>
<td>9.6 ± 0.5657</td>
<td>7.2 ± 0.5657</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.8 ± 0.2828</td>
<td>3.2 ± 0.4243</td>
<td>9.0 ± 0.4243</td>
<td>6.8 ± 0.4243</td>
<td></td>
</tr>
<tr>
<td>BHA</td>
<td>0.02</td>
<td>2.2 ± 0.2828</td>
<td>3.6 ± 0.2828</td>
<td>9.2 ± 0.4243</td>
<td>7.4 ± 0.2828</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>1.6 ± 0.2828</td>
<td>3.2 ± 0.4243</td>
<td>8.8 ± 0.4243</td>
<td>6.8 ± 0.4243</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.2 ± 0.1414</td>
<td>2.6 ± 0.2828</td>
<td>8.4 ± 0.4243</td>
<td>6.2 ± 0.4243</td>
<td></td>
</tr>
</tbody>
</table>

For example, in 2.0% of synthetic antioxidant (BHA), the peroxide value shown was 1.6 ± 0.2828 meq/kg. In 1.0% of synthetic antioxidant applied, the peroxide value shown was 2.0 ± 0.2828 meq/kg and for 0.02% the peroxide value was 2.4 ± 0.4243 meq/kg. Whereas the overall peroxide value for 0.02% of extracted antioxidant and synthetic antioxidant applied in the self-made yogurt was shown lower than the peroxide value for the control yogurt which was 2.4 ± 0.4243 meq/kg and 3.6 ± 0.2828 meq/kg. The synthetic antioxidant (BHA) applied in self-made yogurt shown the lowest peroxide value followed by green tea (Sencha Tea) and white tea (Silver Tea) extracts when applied in the self-made yogurt.

Fig. 2-4, shows the trend of the self-made yogurts that were analyzed from day 1, 7, 18 and 28 by using AOA method. These results show the antioxidant activity were deceased for three types of samples with the different percentages of antioxidants applied in the self-made yogurt. This is because the present of antioxidant activity in the self-made yogurt was used to inhibit the lipid oxidation along this 28 days which to increase the shelf life of the self-made yogurts [31]. Therefore, as the storage period of self-made yogurt increases, the antioxidant activity values were decreases.
increase the shelf life of the food storage. The green tea extract has lower peroxide value compare with white tea extract due to present of catechin in green tea extract inhibited lipid hydroperoxides formation in yogurt during storage [32]. The peroxide value for control was higher compare with others due to the absent of antioxidant and causes the rate of lipid oxidation increases in the yogurt 28 days of storage period.

Based on Fig. 5-7, the self-made yogurts were analyzed from 1, 7, 18 and day 28 by using PV method. The peroxide values shown the fluctuated trend for four types of samples with the different percentages of antioxidants. From day 1 to day 7, the overall peroxide value were slightly increased. In day 18 the peroxide value was rapidly increase, while in day 28 the peroxide values were decreased again.

![Peroxide value (meq/kg) against Days](image)

**Fig. 5.** Peroxide value against days of storage for percentage 0.02%

![Peroxide value (meq/kg) Against Days](image)

**Fig. 6.** Peroxide value against days of storage for percentage 1.0%

![Peroxide value (meq/kg) Against Days](image)

**Fig. 7.** Peroxide value against days of storage for percentage 2.0%

Based on theory, it is normal for the PV value to increase during the storage period. However, the PV will increase rapidly in yogurt fortified with antioxidant after 10 days of storage which indicate that there was high lipid oxidation. After 20 days of storage, there was a sharp decrease due to the decomposition of hydroperoxides into secondary products of lipid oxidation like alcohol, ketones and aldehydes which indicate that the yogurt fortified with antioxidant had the least lipid oxidation at that moment [33]. After 25 days, the control had the highest PV due to the delay decomposition of hydroperoxides into secondary products as there was no antioxidant to catalyze oxidation process. This would cause by the relatively slow peroxidation in the early days and this leads to the time hydroperoxide disintegrated into secondary products [33]. This could explain why the peroxide value fluctuated during 28 days storage.

### III. CONCLUSIONS

The evaluation of the effect from synthetic antioxidants and two different types of tea extract has been done and it has been proved that the tea extracts could be replaced the synthetic antioxidants that give bad effects toward human. Since tea is a natural herbal product with nutritional and therapeutic properties, white and green teas are strongly recommended as a natural ingredients to improve yogurts’s antioxidant properties as a new functional food.

### References


