Kinetics of Extraction and Antioxidant Activity of Tea Brands sold in Ijebu-Ode, Ogun State

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IN PARTIAL FULFILLMENT OF THE REQUIREMENT
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CERTIFICATION

This is to certify that this project work was carried out by **Agbaje, Hammed Adegoke** the Matriculation Number **14/06/4048** and **Ibrahim, Ilyas Abiola** with Matriculation Number **14/06/4065** in the department of Science Laboratory Technology, School of Science, Abraham Adesanya Polytechnic, Ijebu-Igbo under my supervision.

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DEDICATION

This project is dedicated to Almighty God the Alpha and the Omega for His love, care and protection over our lives. Also, to our lovely parents; Mr. & Mrs. Agbaje and Mr. & Mrs. Ibrahim for their love, care and financial assistance toward us.

ACKNOWLEDGEMENT

We give Glory to God for His love, kindness and infinite mercy over our lives. We deeply appreciate our family, friends and loved ones for their support in the polytechnic.

Our deepest gratitude goes to our supervisor Mr. Akinbile A. A. for rendering adequate assistance to us, physically, morally and materially. If not for his positive advice, guidance, courage and adequate supervision, this work might not have come to reality.

We are also grateful to the HOD, Department of Science Laboratory Technology, Mrs. Oluwabiyi B. A. and other member of staff of the department for contributing to our life positively. Thank you all and God bless you (Amen)

We sincerely appreciate the moral and financial supports of our parents; Mr. & Mrs. Agbaje and Mr. & Mrs. Ibrahim. They are wonderful parents indeed. May Almighty God bless you abundantly.

We also appreciate the hospitality our colleagues and friends; Oluwadamilare, Adebukonla, Olasumbo, Mayowa, Oluwakemi, Barnabas, Wale, Ife, Timileyin, Ayomide, Barakat and Abdul-Azeez. We love you all.

ABSTRACT

The kinetics of extraction and antioxidant activity of four different brands of teas (Lipton tea, Hillway green label tea, Toptea, and Hillway Gold,) were investigated and measured using modern method. Several types of commercially available teas, from different manufacturers were tested for antioxidant content using the spectrometric method. Data gathered about antioxidant content of these different tea samples can used to estimate quality and type of tea. The result gotten using this method is also important when trying to account for the normal daily consumable antioxidant of healthy people and also patients using clinical antioxidant therapy.

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CHAPTER ONE

1.0 INTRODUCTION

Tea, a leaf extract of the plant ***Camellia sinensis***, is the second most consumed beverage in the world with an estimated 18-20 billion cups consumed daily and for instance, an estimated average consumption of 1L /person/ day in the United Kingdom (Costal *et al.*, 2002). Originating from China, tea has gained the World's taste in the past 2000 years. Initially, it was consumed only by Chinese Monks, but its use spread to other regions, such as Great Britain, and other Western Countries. Nowadays, consumption of tea is part of people's daily routine, as an everyday drink and as a therapeutic aid in many illnesses (Cabrera *et al.*, 2003).

Depending on the manufacturing process, teas are classified into three major types, namely, **non-fermented green tea** (produced by drying and steaming the fresh leaves and thus, no fermentation i.e. oxidation occurs); **semi-fermented oolong tea** (produced when the fresh leaves are subjected to a partial fermentation stage before drying); and **fermented black and red** (Pu-erh) teas which undergo a full fermentation stage before drying and steaming, although the fermentation of black tea is oxidation and that of pu-erh tea is attained using micro-organism (Zuo et al., 2002).

Worldwide, 80% of the tea consumed is black tea, which is also the most popular drink in Europe, North America, and North Africa (except Morocco), whereas green tea is drunk throughout Asia: oolong tea is popular in China and Taiwan (Wu and Wei, 2002).

The tea beverage has continued to be considered a medicine since the ancient times because of its polyphenols research on the effect of tea on human health has been fuelled by the growing need to provide naturally health diets that include plant derived polyphenols. In line with this, there is need to elucidate how known functional components in foods could expand the role of diet in disease prevention and treatment (Mandel *et al.*, 2006).

There are already growing evidence that polyphenols reduce the risk of heart disease and cancer in humans (Vanessa and Williamson, 2004). In some studies, tea has been associated with anti-allergic action (Yamameto *et al.*, 2004) and antimicrobial properties (Paola *et al.*, 2005). Further studies have demonstrated that the co-administration of drugs with catechins from tea increases the bioavailability of some drugs (Hang *et al.*, 2003).

Moreover some epidemiological studies have associated consumption of tea with a lower risk of several types of cancer including those of the stomach, oral cavity, oesophagus and lungs. Therefore, tea appears to be an effective chemo preventive agent for toxic chemicals and carcinogens (Cabrera *et al.*, 2003; Hakim and Chow, 2004).

1.1 AIMS AND OBJECTIVES

The broad aim and objective of this study is to develop optimal conditions for the extraction of antioxidants from selected tea samples from Ogun State by studying the extraction kinetic and the activity of antioxidants. To achieve this, specific objectives of the research are:

i. To investigate in the kinetic of extraction of tea sample

ii. To determine the antioxidant activity of the extract.

iii. To develop the kinetics and thermodynamics of the extraction under different process parameters such as temperature and contact time.

iv. To develop a mathematical model for optimal extraction condition.

1.2 RESEARCH METHODOLOGY

The adopted procedure for achieving the stated research objectives are itemized in a scheme of activity below as is depicted in Fig. 1.

Specific activities

i. Sourcing, drying and preservation of tea samples.

ii. Hot extraction of the tea samples at different temperatures and contact times.

iii. Determination of the antioxidant activity of the extract derived from (ii) above.

iv. Investigation of kinetics of the extraction under different process parameters such as temperature and contact time.

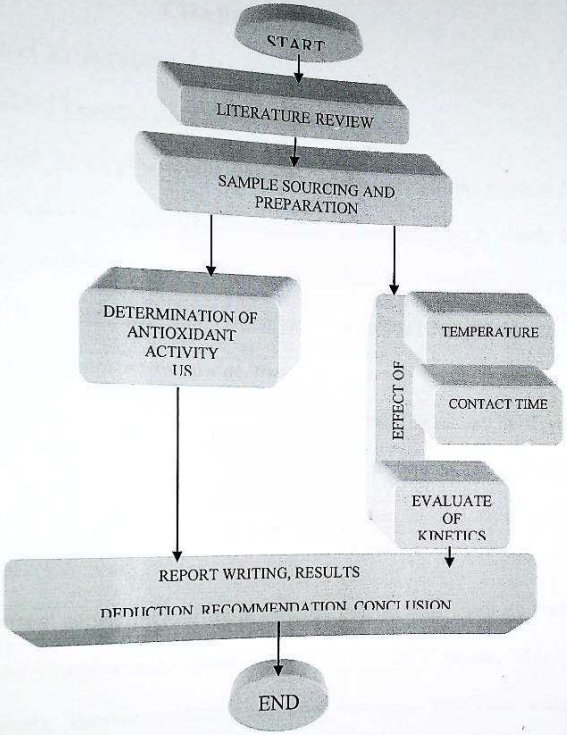

Fig. 1.1: Schematic Representation of Research Methodology

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 TEA PLANT *Camellia sinensis*

Even though the tea plant is cultivated all over the world, it was originated from somewhere. The eco-physiology of the commercially grown tea plant is closely linked with the climate to which it adapts. Tea has been cultivated for centuries beginning in India and China. Now *Camellia sinensis* is cultivated worldwide (Carr, 1972)

Tea is now distributed worldwide and not as the last centuries when it was consumed only by Chinese Monks, it is estimated that average consumption of one liter per person in a day in the United Kingdom (Costal, 2002). Approximately, 76-78% of the tea produced and consumed is black tea. 20-22 % is green tea, and 2% is oolong tea (Costal *et al*., 2002; Zuo *et al*., 2002).

The chemical composition of tea is complex polyphenols, alkaloids (caffeine, theophylline, and theoloromine), amino acids, carbohydrates, protein, chlorophyll volatile compounds, fluoride, minerals and trace elements, and other undefined compounds. Among these, the polyphenols constitute the most interesting group of tea leaf components and exhibit potent antioxidant activity in vitro and vivo (Wu and Wei, 2002).

Tea has been considered a medicine and a healthful beverage since ancient times, but recently it has received a great deal of attention because tea polyphenols are strong

antioxidants. Oxidative stress has been shown to be involved in the pathogenesis of numerous diseases including cancer (Feng *et al.*, 2001; Embola *et al.*, 2002).

Moreover, some epidemiological studies have associated the consumption of tea with lower risk of several cancers including stomach, oral cavity, oesophagus, and lung cancers (Xie *et al.*, 1998; Amentana *et al.*, 2002; Kondo *et al.*, 2002). Tea appears therefore, to be an effective chemo preventive agent for toxic chemicals and carcinogens (Embola *et al.*, 2002).

Numerous studies have also demonstrated that the aqueous extract of the major tea polyphenols possesses anti-mutagic, anti-diabetic, and anti-inflammatory qualities (Feng *et al.*, 2001, Xie *et al.*,, 1998; Amentana *et al.*, 2002, Kondo *et al.*, 2002)

2.2 BIOLOGY AND ECOLOGY

An evergreen shrub, which can grow up to 17 m high in cultivation, it is usually kept below 2 m high by pruning. Leaves of *Camellia sinensis* is bright green in colour and the leaves are shiny, often the leaves are hairy underside. Another part of *Camellia sinensis* plant is the flowering part of it which is scented, occurring singly or in clusters of two to four.

Camellia sinensis is also divided into fruit part, and the fruit's colours are brownish-green, containing one to four spherical flattered seeds (Van, 2005). Tea plant is of two varieties: *Camellia sinensis versinensis* and *Camellia sinensis var.asssaica.*

The *Camellia sinensis var. sinensis* is hardier than Assam tea, and has relatively small and narrow leaves. Its leaves are used to produce green tea and china black tea.

Camellia sinensis var. assamica is much taller in its natural state (than when cultivated) and can grow into a loosely branched tree to a height of about 17 m. It is a less hardy variety leaves, which are used to make Assam (India) black tea. (Schoorel and Van, 2000).

2.3 SCIENTIFIC CLASSIFICATION

The plant *Camellia sinensis* can be scientifically classified to its species level according to Integrated Taxonomic Information System (ITIS) standard on Taxonomy

Kingdom	:	*Plantae*
Sub-kingdom	:	*Viridi plantai*
Infra-kingdom	:	*Streptophyta*
Super-division	:	*Embryophyta*
Division	:	*Tracheophyta*
Subdivision	:	*Spermatophyta*
Class	:	*Magnoliopsida*
Superorder	:	*Asteranae*
Order	:	*Ericales*
Family	:	*Theaceae*
Genus	:	*Camellia*
Species	:	*Camellia sinensis (L) Kuntze*

2.4 IMPORTANCE OF *Camellia sinensis*

2.4.1 Nutritional Importance

Tea is the most important non-alcoholic beverage in the world, and over three million tonnes are grown annually. A major beverage which has given rise to a variety of social convention in different parts of the world (such as tea ceremonies in Japan, and the concept of a tea break in Britain); also tea is consumed worldwide even as part of breakfast, for instance United kingdom, a litre per person in a day (Costal *et al.*, 2002).

2.4.2 Medicinal Importance

Camellia sinensis has been considered a medicine and a healthful beverage since ancient times. It has been recommended for headaches; body aches and pains, digestion, depression, detoxification, and also act as: antioxidant activity, anti-mutagenic and anti-carcinogenic potential, anti-hypertensive effect and cardiovascular disease risk, oral health, solar ultraviolent protection and body weight control (Vision *et al.*, 1995).

2.4.3 Industrial Uses

Camellias have been used in the last centuries as ornamental plants, and to provide food from fermented young leaves, cosmetics, culinary, and industrial oils, high grade charcoal for fuel and tea. In Japan, green tea made from leaves of *Camellia sinensis* that have been steamed, rolling and dried is an integral component of the tea ceremony (Hill *et al.*, 1997).

Besides, camellias have been used in Japan in textiles, ceramics, brewing, cooling, household utensils, tools, printing, crafts, farming, fuel, medicine and food stuffs and cosmetics (Aguiree *et al.*, 2013).

2.5 ANTIOXIDANT

Antioxidant is a substance that inhibits oxidation, especially one used to contract the deterioration of stored product. They are chemicals (both naturally occurring and man-made) that can prevent or slow cell damage. Antioxidant is actually not a substance, its behaviour. Any compound that can donate electrons and counteract free radicals has antioxidant properties.

An antioxidant is a molecule that inhibits the oxidation of other molecules since oxidation is a chemicals reaction that can produce free radicals, leading to chain reaction that may damage cells. Antioxidants such as thiols or ascorbic acid (Vitamin c) terminate these chain reactions.

The term "antioxidant" is mainly used for two different groups of substances; industrial chemicals which are added to products to prevent oxidation, and natural chemicals found in foods and body tissue which are said to have beneficial health effects.

To balance the oxidative state, plants and animals maintain complex systems to overlapping antioxidants, such as "glutathione and enzymes (e.g catalase and superoxide

dismutase)" produced internally or the dietary antioxidants, Vitamin A, Vitamin C and Vitamin E. (Bjelakovic *et al.*, 2013).

Diets containing antioxidant dietary supplements do not improve health nor are they effective in preventing diseases. Randomized clinical trials including supplements of beta-carotene, Vitamin A and Vitamin E singly or in different combinations found no effect on mortality rate (Abner *et al.*, 2011) and cancer risk, or may even increase cancer risk (Cortes-Jofre etral, 2012; Jiang *et al.*, 2010).

Industrial antioxidants have diverse uses, such as food and cosmetics preservations and inhibitors of rubber or gasoline deterioration (Dabeltein *et al.*, 2007). Although certain levels of antioxidant vitamins in the diet are required for good health, there is considerable doubts as to whether antioxidant-rich foods or supplements have anti-disease activity; and if they are actually beneficial, it is unknown which antioxidant (s) are needed from the diet and in what amounts beyond typical dietary intake (Stanner *et al.*, 2004; Shenkin, 2006; Woodside, 2005).

Some authors dispute the hypothesis that antioxidant vitamins could prevent chronic diseases, (Stanner *et al.*, 2004), while others maintain such a possibility is unproved and misguided from the beginning (Hail *et al.*, 2008). Although dietary antioxidants have been investigated for potential effects on neurodegenerative diseases such as Alzheimer's disease, parkinson's disease, and amyotrophic lateral scierosis, (Dimatteo and Esposito, 2003; Rao and Balachandren, 2002).

Antioxidant plays major role in medications. Tiriland mesylate is an anti-oxidant steroid derivative that inhibits the lipid peroxidation, which is believed to play a key in neuronal death in stroke and head injury. It is demonstrated activity in animal models of stroke (Sena *et al.*, 2002). Human trials demonstrated no effect on mortality or other outcomes in subarachnoid haemorrhage and worsened results in ischemic stroke (Bath *et al.*, 2001).

During exercise, oxygen consumption can increase by a factor of more than 10 (Dekkers *et al.*, 1996). However, no benefits for physical performance to athletes are seen with Vitamin E supplementation and six (6) weeks of Vitamin E supplementation had no effect on muscle damage in ultra-marathon runners (Mastaloudis *et al.*, 2006). Other studies indicated that antioxidant supplementation may attenuate the cardiovascular benefits of exercise. Some research suggests that supplementation with amounts as high as 1000 mg of Vitamin C inhibits recovery (Close *et al.*, 2006).

Relatively strong reducing acids can have anti-nutrient effects by binding to dietary minerals such as iron and zinc in the gastro intestinal tract and preventing them from being absorbed (Hurrell, 2003). Notable examples are oxalic acid, tanning and phytic acid, which are high in plant based diet (Hunt, 2003). Calcium and iron deficiencies are not uncommon in diets in developing countries where less meat is eaten and there is high consumption of phytic acid from beans and unleavened whole grain bread (Gibson *et al.*, 2006).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 MATERIALS

3.1.1 Plant Materials

The study was conducted at Ijebu-Igbo Station market, Oke-Sopin , Ijebu North Local Government area of Ogun State, Nigeria. Ijebu-North Local Government is situation at Latitude 6°, 57° N", 0" Longitude 40, 0'E. Four brands of tea samples were selected and procured from the from supermarket in ijebu-Igbo, Ogun State, in the year 2016.

The tea samples were labelled appropriately and kept in a cool dry place prior to the analysis. The samples were obtained from supermarket in the town of Ijebu-Igbo Ogun State, in the year of 2016. The tea samples gotten are; Lipton yellow label tea (a black tea), Hillway green label tea (a black tea), Toptea (a black tea) and Hillway gold label tea (a green tea)

The samples had been manufactured in commercial factories using standard manufacturing conditions. Black tea had been manufactured using physical withering up to 50-65 % moisture contents for 18 hours, fermentation at 24°C for 1-2 hours and a final firing in a fluid bed drier at 120°C for 20-25 minutes. The green tea had been manufactured using standard green tea manufacturing procedures of steaming for 1hour and then final firing in a fluid bed drier at 12°C for 20-25 minutes.

3.1.2 Apparatus

All glassware (100 cm^3 conical flask, 100 cm^3 beakers, 100 cm^3 measuring cylinder, 50 cm^3 volumetric flasks, pipette, funnel and sample bottle) used for the experiments were thoroughly washed, drained and dried prior to their usage. Other apparatus include filter paper, cotton wool and pipette filler.

3.1.3 Chemicals

The chemicals and reagents used in the experiments such as sodium nitrite ($NaNO_2$), sodium hydroxide (NaOH), aluminium chloride ($AlCl_3$) were of analytical grades (AnalaR), obtained from Sigma Aldrich Chemical Co USA, and used without further purification. Also, distilled water was in the experiment for the preparation of reagents.

3.1.4 Equipment

All mass measurements were done using 4-figure analytical balance (Model MT PB153-S). Also, Ultraviolet-visible spectrophotometer (Model – T60V Spectrophotometer) was used to determine the absorbance of the extract.

3.2 METHODS

3.2.1 Preparation of Tea extract

A bag each of tea samples was put into four different 250 cm^3 beakers labelled as A, B, C, and D. 100 cm^3 of hot water at 45°C temperature was added into each beaker, the mixture was allowed to stay for 5 minutes, 10 minutes, 15 minutes, and 20 minutes. 5 cm^3 of the mixture was taken from each of the beakers for the antioxidant activity using UV –visible spectrophotometer. The procedure was repeated using 55°C, 65°C, and 75°C.

3.2.2 Preparation of Reagents

i. **5 $\%^{w}/_{v}$ sodium nitrate ($NaNO_3$)** was prepared by weighing accurately 5 g of $NaNO_3$ using analytical balance into a beaker and dissolved in 100 ml distilled water in a 100 ml standard volumetric flask.

ii. **10 $\%^{w}/_{v}$ aluminium chloride ($AlCl_3$)** was prepared by weighing accurately 10 g $AlCl_3$ using analytical balance into a beaker and dissolved in 100 ml distilled water in a 100 ml standard volumetric flask.

iii. **1.0 M sodium hydroxide (NaOH)** was prepared by weighing accurately 4 g NaOH using analytical balance into a beaker and dissolved in 100 ml distilled water in a 100 ml standard volumetric flask.

3.2.3 Determination of Total Flavonoid

The total flavonoid content of the extract was determined using a colorimeter assay developed by Bao (2005). 5.0 cm^3 of the extract was added to 0.3 ml of 5 $\%^{w}/_{v}$ $NaNO_3$ at zero time. After 5mins, 0.6 ml of 10 $\%^{w}/_{v}$ $AlCl_3$ was added and after 6mins, 2 ml of 1M NaOH was added to the mixture followed by the addition of 20 ml of distilled water. Absorbance was read at 510 nm against the reagent blank and flavonoid content was expressed as mg equivalent.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

Table 4.1: Antioxidant activity of the tea samples extract at 45 °C

Time	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
5	0.470	0.236	0.321	0.311
10	0.767	0.376	0.532	0.423
15	0.837	0.389	0.569	0.623
20	0.640	0.411	0.621	0.701

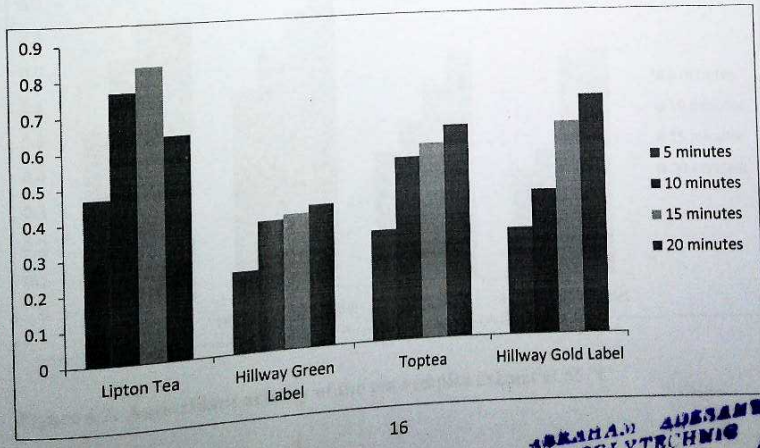

Figure 4.1: Antioxidant activity of the tea samples extract at 45 °C

Table 4.2: Antioxidant activity of the tea samples extract at 55 °C

Time	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
5	0.521	0.615	0.401	0.329
10	0.730	0.732	0.489	0.390
15	0.840	0.850	0.598	0.673
20	0.840	0.881	0.701	0.699

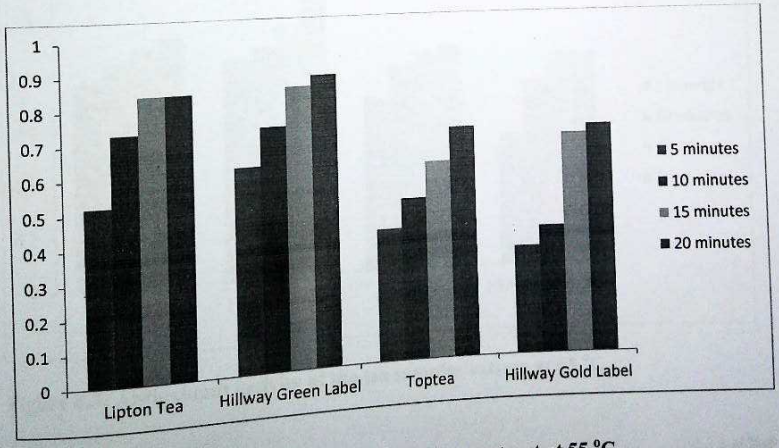

Figure 4.2: Antioxidant activity of the tea samples extract at 55 °C

Table 4.3: Antioxidant activity of the tea samples extract at 65 °C

Time	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
5	0.770	0.850	0.681	0.520
10	0.850	0.890	0.792	0.731
15	0.901	0.971	0.850	0.842
20	0.940	1.081	0.880	0.842

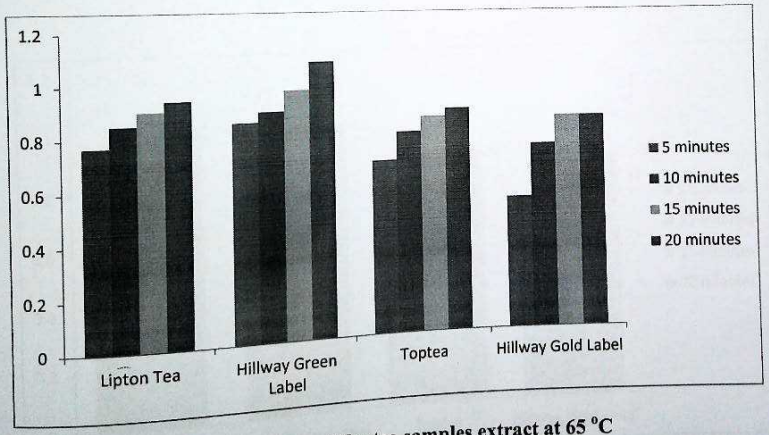

Figure 4.3: Antioxidant activity of the tea samples extract at 65 °C

Table 4.4: Antioxidant activity of the tea samples extract at 75 °C

Time	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
5	0.920	0.947	0.783	0.581
10	0.980	0.989	0.869	0.642
15	0.982	1.005	0.872	0.850
20	1.004	1.007	0.894	0.872

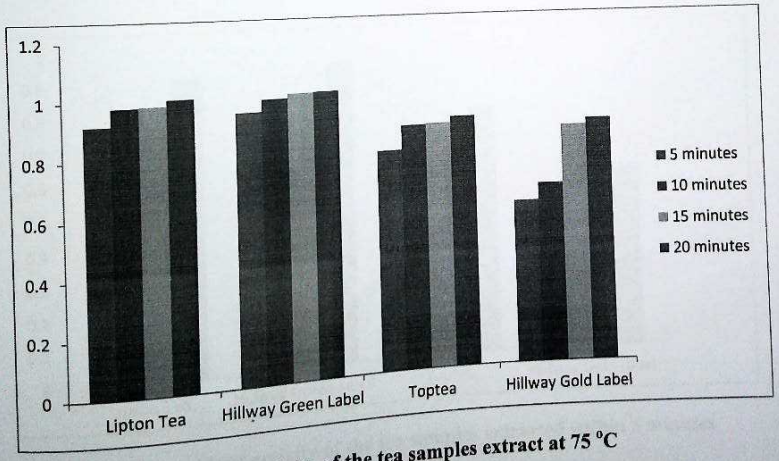

Figure 4.4: Antioxidant activity of the tea samples extract at 75 °C

Table 4.5: Antioxidant activity of the tea samples extracted within 5 minutes

Temperature	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
45	0.470	0.236	0.321	0.311
55	0.521	0.615	0.401	0.329
65	0.770	0.850	0.681	0.520
75	0.920	0.947	0.783	0.581

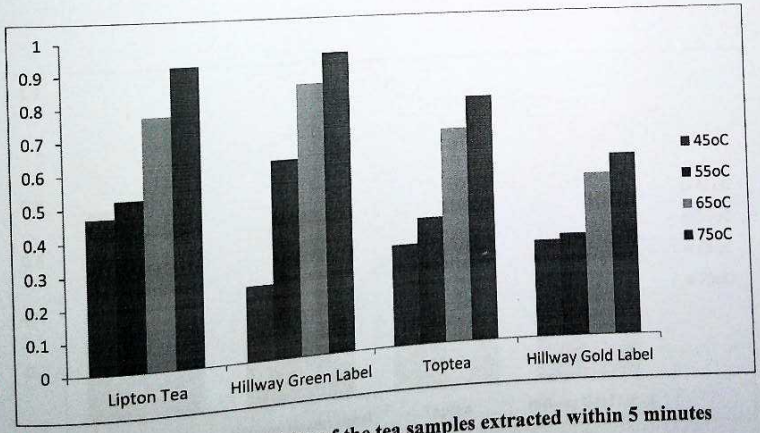

Figure 4.5: Antioxidant activity of the tea samples extracted within 5 minutes

Table 4.6: Antioxidant activity of the tea samples extracted within 10 minutes

Temperature	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
45	0.767	0.376	0.532	0.423
55	0.730	0.732	0.489	0.390
65	0.850	0.890	0.792	0.731
75	0.980	0.989	0.869	0.642

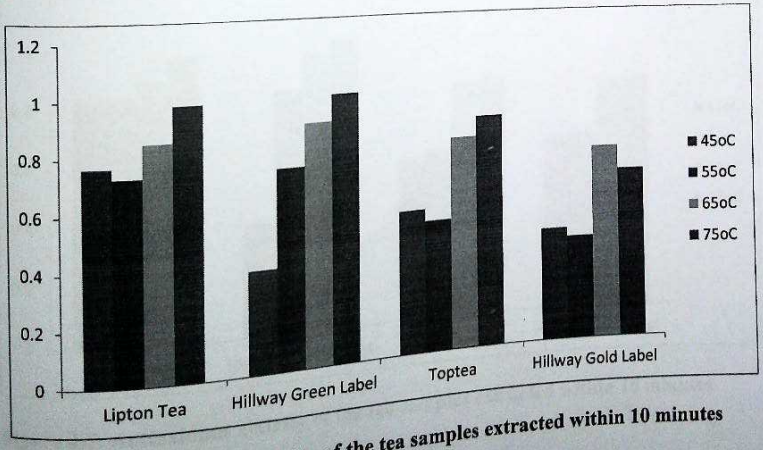

Figure 4.6: Antioxidant activity of the tea samples extracted within 10 minutes

Table 4.7: Antioxidant activity of the tea samples extracted within 15 minutes

Temperature	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
45	0.837	0.389	0.569	0.623
55	0.840	0.850	0.598	0.637
65	0.901	0.971	0.850	0.842
75	0.982	1.013	0.869	0.850

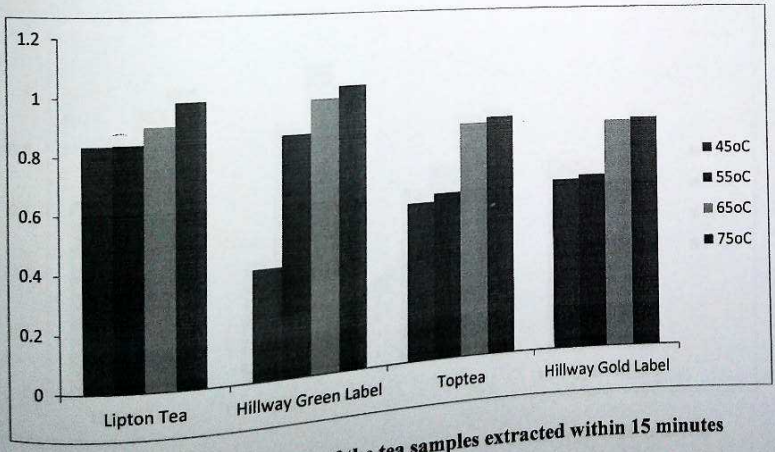

Figure 4.7: Antioxidant activity of the tea samples extracted within 15 minutes

Table 4.8: Antioxidant activity of the tea samples extracted within 20 minutes

Temperature	Lipton Tea	Hillway Green Label	Toptea	Hillway Gold Label
45	0.640	0.411	0.621	0.701
55	0.840	0.881	0.701	0.699
65	0.940	1.081	0.880	0.842
75	1.004	1.007	0.894	0.872

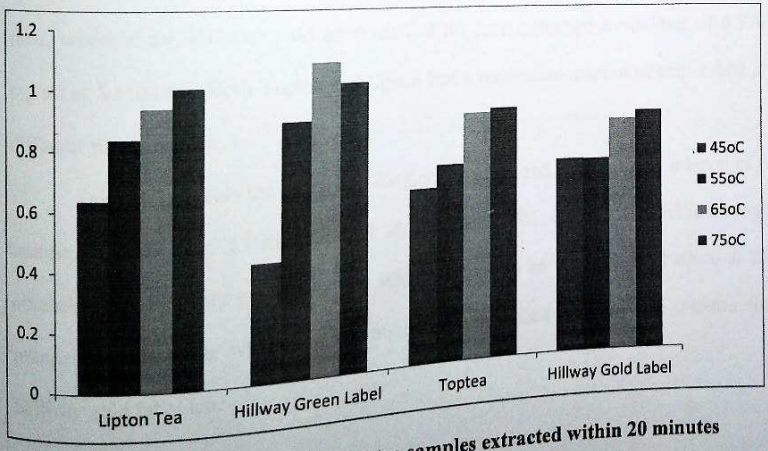

Figure 4.8: Antioxidant activity of the tea samples extracted within 20 minutes

4.2 DISCUSSION

The rate of extraction of antioxidant present in four brands of tea samples namely Lipton, Hillway green label, Toptea, Hillway gold label were investigated and showed the reasonable amount of antioxidant present in brands of teas at different temperature and different contact time.

The table 4.1 shows that the highest amount of antioxidant (0.701 mg/ml) was obtained from Hillway gold label tea at 20 minutes whereby Hillway green label tea had the lowest obtained antioxidant of 0.236mg/ml at 5 minutes contact time; in which the extraction temperature was maintained at $45^{O}C$.

Table 4.2 indicates the activity of antioxidant obtained at $55^{O}C$. Here, Hillway green label tea had a highest antioxidant of 0.881 mg/ml obtained at 20 minutes contact time, whereas the Hillway gold label tea had the least extracted antioxidant of 0.329 mg/ml at 5 minutes. Both Toptea and Lipton had a reasonable amount of antioxidant at different time interval.

Table 4.3 reveals the extraction obtained at $65^{O}C$ and different time interval of 5 minutes, 10 minutes, 15 minutes and 20 minutes. 1.081 mg/ml of antioxidant was obtained from Hillway green label tea which seemed to be the highest obtained at 20 minutes contact time, whereas 0.520 mg/ml of antioxidant was got at 5 minutes for Hillway gold label tea.

Table 4.4 indicates that Lipton tea has consistency and reasonable amount of antioxidant obtained of 0.920, 0.980, 0.982, and 1.004 mg/ml at 5minutes, 10 minutes, 15 minutes and 20 minutes respectively. Tough Hillway green label had 1.007 mg/ml at 20 minutes whereas Hillway gold label tea had 0.581 mg/ml of 5 minutes.

Table 4.5 reveals the activity of extraction obtained at 5 minutes and different temperature $45^{O}C$, $55^{O}C$, $65^{O}C$ and $75^{O}C$. A temperature increases; there is steady increase in the amount of oxidant obtained. The highest amount of oxidant was obtained for all the tea brands at $75^{O}C$.

Table 4.6 indicates the amount of antioxidant obtained at 10 minutes contact time. Lipton tea had 0.767 mg/ml and 0.980 mg/ml at $45^{O}C$ and $75^{O}C$ respectively. Hillway green label tea had the antioxidant of content from 0.376 mg/ml to 0.989 whereas Toptea and Hillway Gold label tea showed variation in extraction at $55^{O}C$.

Table 4.7 shows that 1.013 mg/ml of highest antioxidant was obtained at $75^{O}C$ with 15 minutes contact time for Hillway Green label tea whereas 0.952, 0.869 and 0.850 mg/ml were obtained for Lipton, Toptea and Hillway God respectively. Also, there is close relationship between the amount of antioxidant obtained at $65^{O}C$ and $75^{O}C$ as shown from the figure 4.7.

Table 4.8 reveals that highest amount of antioxidant was obtained for Hillway Green Tea at $75^{O}C$when contact time is 20 minutes and lowest amount of antioxidant 0.411 mg/ml was obtained for the same brand of tea at $45^{O}C$ using 20 minutes as contact time.

Lipton tea, Toptea and Hillway Gold label tea had consistency increase in nount of antioxidant extracted as function of contact time.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The chemical composition of tea is complex polyphenols, alkaloids (caffeine, theophylline, and theoloromine), amino acids, carbohydrates, protein, chlorophyll volatile compounds, fluoride, minerals and trace elements, and other undefined compounds. Among these, the polyphenols constitute the most interesting group of tea leaf components and exhibit potent antioxidant activity in vitro and vivo (Wu and Wei, 2002).

The study evaluated the kinetics of extraction and antioxidant activity of brands of tea sold in Ijebu-Igbo, Ogun State. The antioxidant contacts and activity as a function of polyphenols and flavonoids was investigated of different contact time.

The kinetic data obtained at contact time of 5 minute, 10 minutes, 15 minutes and 20 minutes, were computed alongside with the temperature of mixture of $45^{O}C$, $55^{O}C$, $65^{O}C$ and $75^{O}C$.

The four brands of teas had a reasonable quantity of antioxidant at different temperature and different contact time. Hillway green label teas (a black tea) revealed high contacts of antioxidant whereas top tea (a black tea) had lowest amount of antioxidant.

It can be concluded that the tea samples extract contained essential flavonoid as n antioxidant which can be used for the treatment of oxidative stress diseases such as atique, sleeplessness, headache, and soon.

5.2 RECOMMENDATION

The study revealed the presence of antioxidant in the four brands of tea samples in Ijebu-Igbo, Ogun State. The teas can be recommended as a diety supplement for antioxidant. Also, the extraction condition of temperature not less than $75^{O}C$ and contact time of 15 minutes were recommended for optimum extraction of antioxidant from the four brands of teas samples.

Lastly, further analysis is recommended in order to confirmed the efficiency and potent of the antioxidant obtained from the teas sample against oxidative stress and related diseases associated with oxidative stress.

REFERENCES

bner, E. L., Schmitt, F. A., Mendiondo, M. S., Marcum, J. and Kryscio, R. J. (2011): "Vitamin E and all cause mortality: a meta-analysis" current Aging Science 4 (2): 158-70 def : 10.2174/18746081104020158. PMC 4030744. PMID 21235492.

Amatana, A., Santana-Rois, G., Butter, G. A., Xu, M. R., Whanger, P. D., and Dashwood, R. H. (2002): Antimutagenic Activity of selenium- enriched Green tea toward the heterocyclic aminz-amino-3-methylimidazo (4,5-f) quindine Bid. Trace Elem. Res. 2002, 86, 177-191.

Atone, A. K. and Mansouri, A. (2005): Tea and Herbal extracts their antioxidant activity and phenolic profile. Food chem. vol. 89, p. 27-36. DOI: 10, 1016/j. Food Chem.. 01.075.

Bjelakovic G, Nikolova D, Gluud c. (2013). "meta regression analysis, meta analysis and tria sequential analysis of the effects of supplementation with beta-carotene, vitamin A, and vitamin E singly or in different combinations on all cause mortality: do we have evidence for lack of harm?" PLOS ONE 8 (9): e74558. Bibcode: 2013 PLOSO----- 874558B, doi lo. 1371/ journal pone, 0074558, PMC 3765487. PMID 24040282.

Carr, M. K. V. (1972): The Climatic Requirement of the Tea plant: A review Exp. Agric., 8, 1-14.

Cortes-Jofre M, Renda, J. R., Corsini M. G, Forseca-cortes C., Camballoso M. and Bonfill Cosp x (2012): "Drugs for preventing lung cancer in healthy people". The conchrane Database of systematic Review 10: CD 002141. Doi: 10.1002/14651858.CD 002141.pub 2. PMD 23076875.

Costa, L. M., Gouveia, S. T., and Nobrega, J. A. (2002): Comparison of Heating Extraction Procedures for Al, Ca, Mg and Mn in Tea Samples. Anal Sci., 18, 313-318.

Dabelstein, W., Reglitzk,y A., Schutze, A. and Reders, K. (2007) : "Automotive Fuels". Ulimann's Lnclopedia of Industrial Chemistry. Doi: 10.1002/14356007, al 6-719. Pub 2. ISBN 3-527-30673-0.

Di Matteo V. and Esposito, L. (2003): "Biochemical and therapeutic effects of antioxidants in the treatment of Alzheimer's disease, Parkinson's disease and amyotrophic lateral sclerosis". Current Drug Target.CNS and Neurological Disorders 2 (2) :95-107. Doi 10.2174/1568007053482959. PMID 12769802.

Embola, C. W., Sohn, O. S., Fiala, E. S., and Weisburger, J. H. (2002): Induction of UDP- glucurono syltransferase 1 (UDP-GT1) gene complex by Green Tea in male F 334 rats. Food chem. Toxicol., 40, 841-844.

Feng, Q., Kumagai, T., Torii, Y., Nakamura, Y., Osawa, T., and Uchida, K. (2001): Anti-carcinogenic Antioxidants as Inhibitors against in Tracellular Oxidative Stress. Free Radical Res., 35, 779-788.

Graham, H. N. (1999): Tea. In Wiley Encyclopedia of Food Science and Technology, 2nd ed; Fredrick. J. F. Ed; John Wiley & Sons: New York, 1999; Vol. 1- 4, pp 2292-2305.

Hail, N., Cortes, M., Drake, L. N. and Spallholz J. L. (2008): "Cancer chemoprevention: a radical perspective". Free Radical Biology & Medicine 45 (2) : 97-110. Doi : 10.1016/j. freerad biomed. 2008.04.004. PMID 18454943.

Hara, Y. (1994): Antioxidant activity of tea polyphenols. Intern. Biotechn. Lab. No 2, p. 14.

Hill, R. M., Craig, J. P,, Chancy, M. D., Tennyson, L. M. and Mcculey, L. B. (1977): Utilization of over the counter drugs during pregnancy. Uin obstet Gynecol 20: 38194.

Jiang L, Yang KH, Tian JH, Guan QL, Yao, N, cao N, mi DH, Wu J, ma B, Yang SH. (2010). "Efficiency of antioxidant vitamins and selenium supplement in pro state cancer prevention: a meta-analysis of randomized controlled trials". Nutrition and cancer 62 (6): 719-27. Doi : 10: 1080/01635581, 2010, 494335. PMD 20661819.

Kondo, T., Ohta, T., Igura, K., Hera, Y., and Kaji, D. (2002): Tea catechins inhibit angiogenesis endothelial cell growth, migration of vitro, measured by human and tube formation through inhibition of VEGF receptor binding. Cancer Lett., 180, 139-144.

Schoorel, A. F and Van der Vossen, H. A. M. (2000): *Camellia sinensis (L) Kentze*. In: Van der Voosen, H. A. M and Wessel, M. (eds), Plant Resources of South-East Asia No. 16. Stimulents Backhuys Publishers, Leiden, the Netherlands. Pp. 55-63.

Shenkin, A. (2006): "The Key Role of Micronutrients". Clinical Nutrition 25 (1): 1- 13. Doi 10. 1016/j. clnu. 2005. 11. 006, PMID 16376462

Stanner, S. A., Hughes, J., Kelly, C. N. and Buttriss, J. (2004): "A review of the epidemiological evidence for antioxidant hypothesis" Public Health Nutrition 7(3): 407-22. Doi : 10.1079/PHN 2003543. PMID 15158272.

Van Wyk, B. (2005): Food plants of the World. Timber press, Oregon, USA.

Vanessa C. and Williamson G. (2004): A Review of the Health Effect of Green tea catechins in-vivo animal models. J. Nutr. 134: 3431-3440.

Woodside, J. V., McCall D., McGartiand, C. and Young, J. S (2005): " Micronutrients : dietary intake V. supplement use". The proceedings of the Nutrition society 64(4): 543-53. Doi : 10.1079/PNS 2005464. PMID 16313697.

Wu, C. D. and Wei, G. (2002: Tea as a functional food for Oral Health. Nutrition, 18, 443-444.

Xie, M., Von Bohlen, A., Klocken kamper, R., Jian, X., and Gunther, K. (1998): Multi-element Analysis of Chinese tea (*Camellia sinensis*) by total reflection X-ray fluorescence. Z Lebens. Unters. Forseh., 207, 31-38.

Yamamoto M. M., Inagaki, N., Kitaura, J., Chikumoto, T., Kawahara, H., Kawakami, Y., Kawakami T. and Nagai, H. (2004): O-methylated catechins from tea leaves inhibit multiple protein kinases in most cells J. Immunol. 172: 4486-4492.

Zuo, Y., Chen, H., and Deng Y. (2002) Simultaneous Determination of catechins, caffeine and gallic acids in Green, Oolong, Black and Pu-erh Teas using HPLC with a photodiode array detector. Talanta., 57, 307-316.