CHEMICAL ANALYSIS OF COMMERCIAL TEA AND COFFEE BEVERAGES

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D E C L A R A T I O N

"I hereby declare that all the work in this thesis is my own work and that it has not been presented elsewhere as a requirement for a degree."

E.B. OLAWORE

1/3/80
Date

THESIS RECOMMENDATION

We hereby recommend that the thesis prepared by Miss E.B. Olawore entitled "Chemical Analysis of commercial tea and coffee beverages" be accepted in partial fulfilment of the requirements for the degree of M.Sc. Analytical Chemistry.

Internal Examiner	External Examiner
Date	Date

DEDICATION

Dedicated to my parents, Mr. C.O. Olawore and Mrs. E.O. Olawore, and to all those who love knowledge.

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ABSTRACT

Analysis was performed on some tea and coffee samples. Some of the brands of the tea and coffee samples were imported products while the others were processed and packed in Nigeria. The samples were purchased from supermarkets in Zaria. They were analysed for their moisture content, ash content, water-soluble ash content, alkalinity of the soluble ash, tannin content, caffeine content, protein, ether extract and for some inorganic elements which include potassium, phosphorous, magnessium, calcium and copper.

The result of the work showed that the tea and coffee samples analysed were of similar qualities with other tea and coffee samples analysed and reported in literature with a few exceptions. The exceptions include moisture content, water-soluble ash and caffeine contents. The moisture contents of a few of the samples were found to be higher than recommended values while their caffeine contents were found to be lower. And, the water-soluble ash of some coffee samples were found to be significant-ly lower than the literature values.

The samples imported were compared with the ones processed and packed in Nigeria for the above constituents. It has been suggested that legal requirements be laid down for the tea and coffee samples processed in the country and also for those imported in. It was further suggested that analysis of more brands of tea and coffee beverages be carried out to have more data about the different samples in the Nigerian market.

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In these times of change the most precious gift is the gift of knowledge. Once given, no one can take it away, nothing can erode or destroy its value.

Research Objective.

Tea and Coffee are well accepted drinks in Nigeria. Very few brands of tea and coffee are manufactured (made from the raw materials) locally but some already formulated ones are blended and packed. This however, does not meet the demand for these beverages and large quantities are therefore imported from other countries like Ivory Coast and England.

Analysis of these beverages have not been reported done in Nigeria on the brands in the market. The aim of this work is to provide a reliable source of information on some of the brands in Nigerian markets. It is hoped that useful recommendation will be made to the authority in charge of the importation and local manufacture of the beverages at the end of the work.

In this work, some tea and coffee brands manufactured locally and some imported ones will be analysed for their major constituents. The results obtained from the analysis of the locally manufactured tea and coffee samples will be compared with those of the imported ones. These results will then be compared with similar analyses recorded in literature.

CHAPTER I

1.1 INTRODUCTION

Tea and Coffee are habitually drunk not only in the early morning but as refreshments with all meals, and possibly between them. They are agricultural products of considerable world value. They are a pleasure to drink but do not necessarily add to the caloric intake (Wellman, 1961a).

Tea and Coffee manufacturers make special efforts to see that their products are of good quality. The value of these products is first dependent on their quality and flavour. This is so because a buyer will not knowingly purchase a coffee or tea that is of poor quality. Market valuation of tea and coffee are also affected by such factors as appearance and keeping properties on storage.

For quality control, professional tasters are hired. The tea (or coffee) taster describes and evaluates the tea (or coffee) and is able to appreciate small differences in the flavours (Harler, 1963a). However, analytical methods, when developed, should be more suitable and reliable (in quality control) when it is desirable to maintain records of the properties of the beverages manufactured. The analytical method may therefore be expected to be developed as a supplementary means of control during manufacture.

1.2 Tea and Coffee Production.

1.2.1 Species of Commercial Interest.

Tea

Tea is made from the young shoots, consisting of two or three leaves, and the unopened terminal bud of genus Camellia and Thea species. The camellias are evergreen trees or shrubs. The tea plant has been cultivated for so long that its place of origin is a matter of speculation (Eden, 1976a). The major producing countries are in South East Asia and Africa. Tea planting is however of no significance in Nigeria.

The three species of commercial interest are C. Sinensis. C. taliensis, and C. irrawadiensis. Camellia irrawadiensis contains no caffeine while the other two species contain caffeine (Harler, 1963b).

Coffee.

The trees that produce the coffee beans of commerce belong to the genus Coffea. Details of their botany are not very well known (Wellman, 1961b). There are different species of cultivated coffee, the most important ones being Coffea arabica, Coffea canephona, Coffea liberica and Coffea excelsa. According to Sands (1959), the main Coffee growing area of Nigeria is in the Western part of the country. There are some coffee in the Eastern part, but the

quantity is very small. In the Northern region both arabica and robusta are grown. The former is confined to the high altitude of the Jos plateau and the latter to a belt running east west through Kabba, Lokoja and across the Niger in Igala division. The main varieties of coffee grown in the Western part are Coffea canephora Pierre, and Coffea liberica Bull. A large portion of this coffee is exported out and the remaining processed in the grinding and roasting industry in the country.

1.2.2. Production processes.

Tea.

Tea leaf is rich in polyphenols and in two enzymes; pectase and polyphenol oxidase. These play important roles during the production process. There are four stages in the manufacture of tea and these are:-

(i) Withering:- The plucked young shoots of tea plants are exposed to air, on racks to soften. During this time the tea loses moisture mainly from the leaves. It is considered that during this process some changes take place, at present undefined, which make for quality in tea. The prime object in withering is to prepare the leaf for rolling by making the leaf tissues flaccid and permeable to the juices which the rolling will wring out and spread evenly upon the surface (Eden, 1976b).

(ii) Rolling:- Rolling twists the leaf and ruptures the cells. As a result the polyphenols and the enzymes become thoroughly mixed and exposed to the atmosphere.

(iii) Fermentation:- Fermentation starts in the rollers. The time of fermentation is made short because the soluble content capable of being extracted into the brew decreases as fermentation progresses (Eden, 1976b). Over three-quarters of the polyphenols in the tea leaf belong to a group known as flavanols. These are also defined as catechins and can readily turn brown. During fermentation the catechins are oxidised to O-quinones by the polyphenol oxidase in the presence of oxygen. A series of condensation reactions follow and theaflavins (yellow bodies) and thearubigins (red and brown bodies) are formed. The theaflavins and thearubigins are the tannins in tea.

(iv) Firing:- This is drying using hot air. The moisture content is rapidly reduced till the leaf becomes a hygroscopic body and then heats up. During this process the enzyme responsible for fermentation is inactivated.

Teas as sold might be blends of up to twenty different types of tea. Blanding is decided upon in relation to the district of origin, flavour, colour, price and often the hardness of the water in the area in which the tea is likely to be infused (Pearson, 1976a).

During packaging, foreign leaves and used tea leaves are sometimes mixed with the freshly manufactured tea leaves. These, and some other samples that contain excessive stalk or are musty constitute adulterants in tea. This is however said to be virtually a relic of the past (Williams, 1964).

Coffee.

The fruits, called berries, are picked as soon as they turn red. In a normal berry there are two seeds and these are the coffee 'beans' of commerce. Each bean is enclosed in thin membranes (Silverskins), and parchment-like shells. The two seeds and their coverings are enclosed in a thin mucilaginous substance. There are about five stages in the manufacture of coffee and these are:-

(i) Pulping:- During pulping the two seeds are separated from the mucilaginous substance by use of a pulping machine.

(ii) Fermentation:- The mucilage is best removed from the beans by a process of fermentation. The fermentation process does not alter the composition or flavour of the beans and it is carried on for just as long as it takes for the mucilage to liquefy and dissolve. The slippery, slimy covering to the bean is no longer present when fermentation is complete (Haarer, 1962a). The fermented beans, or the parchment coffee are then thoroughly washed.

(iii) Drying:- The parchment Coffee is either sun-dried or dried in a flow of hot air. The beans shrink within the parchment shell and the silverskin loosens. After drying the coffee is allowed to cool down before it is bagged and stored in bulk or before it is polished.

(iv) Polishing and Grading:- The parchment covering and the silver Skins are removed and the bean polished. Phospho-bronze polishers are used. A shiny surface makes the bean look attractive and clean.

(v) Roasting and Grinding:- The cured coffee beans are roasted to a bright colour. During roasting the coffee beans turn golden yellow, as moisture is expelled, then to russet brown as cracking begins and then to a bright colour (Haarer, 1962b). If the coffee is not to be sold whole then it is ground and packed.

Sometimes coffee grounds is packed with some other vegetable products like saw dust, carrots or peas (Wellman, 1961c). These constitute adulterants in the coffee. However some of these coffee-adulterants have been accepted in certain parts of the world because of their taste and flavour. Cramer (1957) pointed out that roasted seeds of a leguminous shade tree were used in Java, and the result was one of the best tasting substitutes.

And according to Hewitt (1872), there were some cases in which adulterants were of good flavour, in a few instances approaching coffee, e.g. dry iris root, and especially roasted rye. Chicory is perhaps the most popular of all adulterants.

1.2.3. Types of Tea and Coffee.

Tea.

There are a number of ways in which the tea leaf may be prepared. However most tea are designated green or black. The green tea is the unfermented tea. The enzymes responsible for fermentation are inactivated before rolling begins. The black tea is the fermented tea. In the mountain areas of Shan Hills and on the borders of Yunnan a form of 'pickled tea' is made for use as a masticatory (Eden 1976c). Oolong tea is only partially fermented (Pearson, 1976a).

The grades in general production are named as follows: Broken Orange Pekoe; Broken Pekoe; Orange Pekoe; Pekoe; Souchong; Broken Oragge Pekoe Fannings; Fannings and Dust (Eden, 1976d). According to Eden (1976d) the grade specification is entirely artificial, though not completely arbitrary. Broken Orange Pekoe should contain a high proportion of buds (tip): Orange Pekoe is characterized by the abundance of twisted tender stalk. The Pekoe and Souchong grades are more compact and dense.

The Fannings are often used for tea bags for quick infusion. Instant teas are produced by drying the infusions from black teas.

Coffee.

The different types of coffee are made after the production of the roasted coffee. These are the pure coffee, French coffee, Viennese coffee, Caffeine-free coffee, liquid coffee extracts and solid coffee extracts. The pure coffee is made by grinding roasted coffee with no other substance present. The French coffee is made of coffee and chicory bits with at least 51% of the mixture being coffee. The Viennese coffee is coffee with fig flavouring with 85% being coffee (Pearson 1976b). In caffeine-free coffee, the caffeine is removed by liquid treatment (Wellman,1961c). Liquid coffee extracts consist of a mixture of a concentrated decoction of coffee with added sugar. Coffee extract, coffee and chicory extract, and coffee and fig extract products are also made as liquid extracts. Solid coffee extracts are also known as "Instant coffees". These are prepared by drying coffee decoctions. A few products are made by mixing glucose syrup with the decoction before drying. Solid extracts of Coffee and Chicory are also prepared (Pearson,1976b).

1.2.4. Quality of Tea and Coffee Beverages.

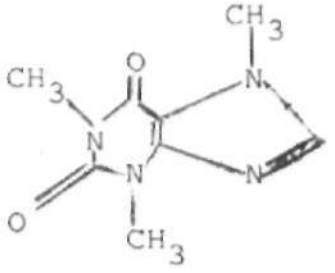
Difficulties arise in defining quality. This may mean a quantitatively measurable character associated with the taste of one or several specific compounds. It may however be a description applied to a tea or coffee possessing all-round good cup characters of which colour, brightness, briskness strength and aroma are all components (Hainsworth 1961). According to Roberts et al (1961), quality in tea is not determined by polyphenolic oxidation products alone. There are other important factors among which caffeine and the volatile substances responsible for aroma may be mentioned. Stahl (1962) inferred that the flavour of tea is dependent on a number of volatile substances including terpenoid ans sulphur containing compounds, fatty acids, alcohols, esters and carbonyl compounds. There appears to be a significant loss in flavour and theaflavins during the manufacture (infusion and drying) of instant tea (Anon, 1968). In good quality teas, according to Pearson (1976a), ratio of caffeine to tannin is about 1:3.

The pyrolysis volatiles from proteins are of some importance in relation to coffee flavours. The volatiles include a large number of compounds such as acids, alcohols, aldehydes and phenols (Pearson, 1976b).

Moncrieff (1950) described only two basic flavours in coffee: 'freshness', with its desirable aroma and flavour and 'Staleness' that develops when it is kept. Staling of ground coffee is now considered to be related to loss of volatile aroma constituents, which is accelerated by uptake of moisture. In order to conserve the flavour of instant coffees, the temperatures used during processing are kept as low as possible to reduce the loss of volatile constituents (Pearson, 1976b).

1.3 The physiological and pharmacological aspects of tea, coffee beverages.

In tea and coffee, the sole component recognised for its medical and socially stimulating value is the alkaloid caffeine. A cup of tea or coffee is reported to contain between 100 and 150mg of Caffeine (Timson, 1978). The chemical name of caffeine is given as 1, 3, 7-trimethylxanthine by Von Richter (1934) with the structure as



Caffeine has a slightly bitter taste in some concentrations, but is virtually without taste in dilute proportions. According to medical studies (Timson, 1978), it is a mild stimulant, mildly addictive drug with a good effect that is both temporary and transitory. It is especially valued because there is no depression either initially or eventually accompanying its stimulatory action. It has been claimed that when taken in reasonable measures it reduces a craving for sweets, by stimulating the production of those adrenal hormones that cause blood sugars to be increased (Davis, 1954). Trigg (1922) pointed out that stimulatory effects of caffeine results in increased capacity for both mental activity and muscular work and also claims that in either of these, the stimulus is not automatic but depends upon the willingness of the subject to react to those heightened conditions. Through caffeine stimulation, work is made more of a pleasure and the stimulus can be of great help. Timson (1978) agrees that caffeine stimulates the nervous system and that it certainly causes a feeling of wakefulness in man. According to him, caffeine is easily absorbed from the gut and it is quite rapidly distributed to all the tissues and organs of the body. The half-life of caffeine in man shows some variations from one person to another but is usually between three and five hours. No day to day accumulation of the drug is reported, it disappears from the body almost completely overnight.

Since each morning is started almost free of caffeine many people find it difficult to face the new day without a breakfast of tea or coffee. Great excesses of coffee are known to give unpleasant tremors, nervousness, heart palpitation and other temporary discomforts (Wellman, 1961c). The quantity of tea and Coffee that makes the excess however varies from man to man.

Caffeine is indeed an active drug and an overdose can be fatal. However the lethal dose is 10grams and this requires the very rapid consumption of 80 to 100 cups which is an almost impossible feat (Timson 1978).

Tea and Coffee beverages have little food value in themselves, except for that given by added foodstuffs such as milk, cream and sugar (Jacobs 1962).

Tannins are present in tea and coffee. They are a group of polyphenolic compounds that have certain characteristics in common. For example, they are known for their astringent taste which is important in foods (Bate-Smith, 1954a, b. and Joslyn et al, 1964) They are also known for their ability to form coloured solutions and precipitates with iron and other metals. Tannins also have therapeutic value. Clinically they are observed to have a constipating effect in the control and treatment of diarrhoea (Jones 1965; and Sollman 1957).

They are able to precipitate proteins and because of this they can be used to shrink mucous membranes, for example on burns (Joslyn, 1970). However, this ability to bind irreversibly to protein renders the protein indigestible by intestinal enzymes (Goldstein et al, 1965). It has also been found that absorption of iron is inhibited by tea (Disler et al, 1975). The effect is attributed to the formation of insoluble iron tannate complexes. It was also suggested by the authors that tannin-containing beverages may contribute to the pathogenesis of iron deficiency if the diet consists largely of foods of plant origin.

Mgaloblishvili et al (1972) reported that green tea infusion has a moderate diuretic effect and is used in the treatment of hypertension. And according to Farsam et al (1978), the practice of giving infants diluted tea between breast feedings may have some dental benefit. This conclusion was arrived at after finding that about 3.8g of tea daily would supply 0.34 to 0.44 mg fluorine. According to Yamanishi et al (1972), there is no reason to assume a relation between coffee consumption and development of cancer in the ovary, prostrate, pancreas, bladder or the gastro - intestinal tract, nor is the development of leucaemia considered to be related to coffee consumption.

Dawber (1976) found that there is no significant relation between coffee consumption and coronary heart disease or related disorder in both men and women. Hennekens et al (1977) also attested to this fact. And according to Heydens et al (1977), there is no strong or consistent relation between death rates from cerebrovascular disease and coronary disease and coffee drinking habits. It has been concluded therefore that the consumption of Caffeine by drinking normal amounts of tea, or coffee does not appear to involve any appreciable risk to man. Man has learned to live with it over many generations.

CHAPTER II

MATERIALS AND METHODS

2.1. SAMPLE COLLECTION AND DESCRIPTION.

The tea and coffee samples analysed were got from both the Leventis Stores and Kowa Stores in Zaria. Five tea samples and five coffee samples were chosen. The choice was made in such a way that, overall there were three types of coffee samples and two types of tea samples. The types of coffee samples are (i) instant coffee (ii) French coffee and (iii) Turkish blend coffee; the types of tea samples are (i) tea leaves packed as teabags and (ii) tea leaves not packed as teabags.

The tea and coffee samples also fall into two categories: the samples inported into Nigeria from other countries and the ones processed and packed in Nigeria. Below is the description of each sample.

Sample description

TEA SAMPLE NUMBER	DESCRIPTION
T_1	Lyons Tea Earl Grey. Packed by Hersteller - Conditionne' Par. Overseas Trading Corporation (1939) Ltd., Jersey, British Isles. The tea leaves are dark in colour and of very small particle sizes. They are packed in teabags. Present also in each teabag are certain white water soluble particles. The infused tea has a sharp aroma. The weight of tea in each bag is about 2g and there are 25 bags packed in a packet.
T_2	CTC Lipton tea quality No. 1. Processed by Lipton Limited, Salisbury Square, London, E.C.4. England. The tea leaves are black and of small particle sizes. The leaves are packed in porous tea bags. Cost per kilogramme is about ₦25.00
T_3	Lipton tea Yellow Label quality No. 1. Blended and packed for the proprietors Lipton Limited by Lipton of Nigeria Limited. The leaves are black and of fairly large particle sizes. They are packed in bulk in polythene bags. Cost per kilogramme is about ₦7.50.

TEA SAMPLE NUMBER — DESCRIPTION

T_4 Lipton Family tea. Packed for Lipton Ltd by Lipton of Nigeria Ltd. The leaves are of very small particle sizes and are black in colour. They are packed in polythene bags and cost about ₦6.00 per kilogramme.

T_5 CTC Lipton tea quality No. 1. Blended and packed for the proprietors Lipton Ltd by Lipton of Nigeria Ltd. The tea leaves are black and are of small particle sizes. They are packed in porous tea bags. Cost per kilogramme is ₦12.50.

COFFEE SAMPLE NUMBER.

C_1 Hills Bros instant Coffee. Distributed by Hills Bros. Coffee, INC. San Fransisco, CA 94119, U.S.A. The coffee particles are fine and packed in bottles with tight-fitting lids. The cost per kilogramme is ₦49.00.

C_2 Lipton's French Coffee. Processed and packed for the Proprietors Lipton Limited by Lipton of Nigeria Limited. The coffee beans and Chicory are ground into small particles. The ground coffee beans and chicory are packed in tins with plastic lids. Cost per kilogramme is about ₦4.00

C_3 Nescafe' instant coffee. Manufactured in Ivory Coast by CAPRAL, under agreements with the trade mark owners NESTLE. The coffee particles are granular and are packed in tins with tight-fitting lids. Cost per kilogramme is ₦20.00.

COFFEE SAMPLE NUMBER.	DESCRIPTION
C_4	Mouka turkish blend coffee. Processed and packed by the Nigerian Torrefaction Coffee Ltd. Oregun Industrial Estate, Ikeja. The coffee is in the form of fine powder and has a strong aroma. It is packed in tins with well-fitting lids under vacuum. Cost per kilogramme is ₦13.50.
C_5	Mouka French blend coffee. Processed and packed by the Nigerian Torrefaction Coffee Ltd. Oregun Industrial Estate Ikeja. The ground coffee beans and chicory are in the form of small particles and have a weak aroma. They are packed in tins with well fitting lids under vacuum. Cost per kilogramme is ₦13.50.

2.2. PREPARATION OF SAMPLES

The samples analysed were in small packages and since they were processed food products, each was taken as representative.

They were prepared for analyses in order to make them homogeneous so that any portion subsequently taken for analysis was regarded to represent the whole foodstuff. The samples were thoroughly mixed by pouring from one clean container to the other. They were dried at 100°C for 5 hours as recommended by Pearson (1976 a and b). The dried samples, apart from the instant coffees were then ground into powder and stored in labelled, dried screw cap bottles.

2.3. DETERMINATION OF MOISTURE CONTENT

The indirect distillation (or drying) method was used. This involves the measurement of the weight loss due to the evaporation of water from the sample.

About 5g of each tea and coffee sample was accurately weighed into separate dried crucibles. The tea and coffee samples were then heated to constant weight in an air oven at 100 $\pm$ 1°C, (Pearson, 1976a,b).

The total loss in weight of each sample was taken as the amount of moisture present in the sample. This method was rapid and gave consistent results.

$$\text{Percent moisture content} = \frac{\text{Total loss in weight}}{\text{Weight of Original sample.}} \times \frac{100}{1}.$$

2.4. DETERMINATION OF THE ASH CONTENT (Pearson 1976a).

The ash of a foodstuff is the inorganic matter remaining after the organic matter has been burnt off by ignition. About 2g of each dried tea and coffee sample was accurately weighed into previously ignited porcelain crucible. The crucible with the sample, was placed in a muffle furnace and ignited at 500°C for the tea samples and at 600°C for the coffee samples. Complete conversion to ash was assumed when homogeneous greyish to brownish ash residues were obtained. The residues were allowed to cool in a dessicator before weighing.

$$\text{Percent ash content} = \frac{\text{Weight of ash}}{\text{Weight of the original sample}} \times \frac{100}{1}.$$

2.5 DETERMINATION OF WATER SOLUBLE ASH (Pearson, 1976c)

Water-soluble ash is the part of the ash that is soluble in water.

The ash obtained from Section 2.4, for each sample, was boiled with 25cm^3 water. This was filtered through an ashless filter paper. The residue and filter paper were thoroughly washed with hot water. They were then ignited in the original crucible at 500^{o}C. The residues were allowed to cool in a dessicator before weighing the water - insoluble ash.

$$\text{Percent water-insoluble ash} = \frac{\text{Weight of water-insoluble ash}}{\text{Weight of original dried sample.}} \times \frac{100}{1}$$

and Percent water-soluble ash = (Percent total ash-Percent water-insoluble ash).

2.6. DETERMINATION OF ALKALINITY OF SOLUBLE-ASH (Pearson, 1976c)

The filtrate for each sample, from section 2.5 was allowed to cool and titrated with 0.05M sulphuric acid using methyl orange as indicator. This gave the alkalinity of the soluble ash which was calculated as K_2O for tea and K_2CO_3 for coffee (Pearson, 1976a and b).

The corresponding reactions are represented

(i) for the tea samples by

$$K_2O + H_2O \longrightarrow 2KOH.$$

$$2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O.$$

1 mole K_2O ≡ 2 moles KOH ≡ 1 mole H_2SO_4.

i.e. 1 mole K_2O ≡ 1mole H_2SO_4

1millimole K_2O ≡ 1 millimole H_2SO_4.

1 mole of K_2O = 94g

∴ Weight of K_2O in ash = 0.05 X 0.094 X Volume of acid.

$$\% K_2O \text{ (alkalinity) of ash} = \frac{0.05 \times 0.094 \times \text{volume of acid}}{\text{Weight of dry sample}} \times 100$$

(ii) for the coffee samples by

$$K_2CO_3 + H_2SO_4 \longrightarrow K_2SO_4 + H_2O + CO_2.$$

1 mole K_2CO_3 ≡ 1 mole H_2SO_4.

1 millimole K_2CO_3 ≡ 1 millimole H_2SO_4.

1 mole of K_2CO_3 = 138g

∴ Weight of K_2CO_3 in ash = 0.05 X 0.138 X Volume of acid.

$$\% K_2CO_3 \text{(alkalinity) of ash} = \frac{0.05 \times .138 \times \text{volume of acid}}{\text{Weight of dry sample}} \times 100$$

2.7. DETERMINATION OF WATER EXTRACTIVES. (Pearson 1976a)

The water-soluble extractives of tea and coffee were determined as described below.

A known weight of dried sample, about 2g, was boiled with $100cm^3$ of water under reflux for one hour. This was filtered through a filter paper into a $250cm^3$ volumetric flask. The filter paper with the residue, was reboiled with another $100cm^3$ water and filtered into the volumetric flask. The filtrate was cooled, made up to mark with water and mixed. $50cm^3$ of it was pipetted into a dried, weighed crucible and the water evaporated on a water bath. The crucible was then dried to constant weight in the 100^oC oven.

Total extractives = Weight of extractives in crucible X 5

$$\text{Percent extractives} = \frac{\text{Total extractives}}{\text{Weight of dried sample taken}} \times \frac{100}{1}.$$

2.8. MACROSCOPIC EXAMINATION OF ROASTED COFFEE (A.O.A.C. 1970a)

This is only qualitative. It is based on the principle that ground roasted coffee (if not overroasted) is lighter than most adulterants and floats on top of water.

Some ground coffee samples were sprinkled on cold water in a jar and stirred slightly. Particles of pure coffee floated while those of adulterants sank. Chicory bits, as expected, turned the water brown where present.

2.9. DETERMINATION OF TANNIN CONTENT

The modified Lowenthal's permanganate oxidation process. (Pearson, 1976a) was adopted.

This is based on the precipitation of the tannins with gelatin in the presence of kaolin and on the oxidation of tannins with acid permanganate. The method involves titration of the tea or coffee extract before and after the precipitation of the tannins with gelatin in the presence of kaolin. The difference in the titre values of the two titrations gives the tannin titre, i.e. the amount of permanganate reduced by tannin. This differential approach is needed because substances other than the tannins can also reduce the permanganate.

2.9.1 Reagents

(i) Indigo Carmine solution:- prepared by dissolving 1.5g indigo carmine in 1dm^3 water containing 50cm^3 conc. sulphuric acid.

(ii) Gelatine solution: prepared by soaking 25g gelatine for 1 hour in saturated sodium chloride solution. The mixture was warmed until the gelatin dissolved. The solution was then cooled and made up to 1 dm^3 with saturated sodium chloride solution.

(iii) Acid Sodium Chloride Solution: prepared by adding 25cm^3 conc. H_2SO_4 to 975cm^3 saturated sodium chloride solution.

(iv) Kaolin (China clay).

(v) Potassium permanganate solution 0.004M: prepared by dissolving 0.632g of potassium permanganate crystals in 1 dm^3 of water.

(vi) Sulphuric acid about 98%

2.9.2 METHOD

Accurately known weight, about 5g, of each sample was boiled with 400cm^3 distilled water for 1 hour. The extract was filtered through cotton wool into a 500cm^3 volumetric flask, allowed to cool and made up to mark with distilled water. The extract was labelled A.

40cm^3 of this extract was pipetted into a 100cm^3 volumetric flask, 20cm^3 gelatine solution was added and the mixture made up to mark with acid sodium chloride solution. The mixture was then poured into a conical flask containing 6g Kaolin and shaken for 15 minutes. This was filtered through a filter paper and the filtrate labelled B.

4cm^3 extract A $\equiv$ 10cm^3 extract B.

$4cm^3$ of extract A was pipetted into a large beaker, $10cm^3$ indigo solution was added and the mixture diluted to $300cm^3$ with distilled water. This was titrated with 0.004M potassium permanganate solution from a burette. The colour changed from blue through green to yellow. The titre value was taken to be X cm^3.

$10cm^3$ of extract B was pipetted into a large beaker, $10cm^3$ indigo solution was added and the mixture diluted to $300cm^3$ with distilled water. This was titrated with 0.004M potassium permanganate solution as was extract A. The titre value was take to be Y cm^3.

$10cm^3$ of the indigo solution was diluted to $300cm^3$ with distilled water and titrated with the permanganate solution. This was taken as the blank for extract A.

$4cm^3$ acid sodium chloride solution was added to $10cm^3$ indigo solution and diluted to $300cm^3$. This was also titrated with the permanganate solution and taken as the blank for extract B.

The tannin titre was given as

(X-blank for A) - (Y-blank for B)

$1cm^3$ 0.2M potassium permanganate ≡ 0.0416g tannin (Pearson 1976a). So that $1cm^3$ 0.004M $KMnO_4$ ≡ 0.000832g tannin. The amount of tannin = tannin titre X 0.000832g tannin and Percent tannin = $\frac{\text{Weight of tannin}}{\text{Weight of sample in } 4cm^3 \text{ extract A}} \times \frac{100}{1}$.

2.10 DETERMINATION OF CAFFEINE CONTENT OF TEA.

The modified Bailey-Andrew method (AOAC, 1970b) was used.

In this method caffeine is liberated from its combination in the tea leaves by the use of heavy magnessium oxide. It is then extracted with chloroform. The chloroform is evaporated off and the purity of the crude caffeine tested by determining its nitrogen content by the micro-kjeldahl method.

2.10.1 Reagents.

(i) 10 percent sulphuric acid: prepared by making up 25cm^3 concentrated sulphuric acid to 250cm^3 with distilled water.

(ii) 1 percent Sulphuric acid: prepared by making up 10cm^3 concentrated Sulphuric acid to 1dm^3 with distilled water.

(iii) 0.01M Hydrochloric acid:- prepared by diluting 0.5M standard hydrochloric acid.

(iv) 1 percent potassium hydroxide: prepared by dissolving 1g potassium hydroxide pellets in distilled water and making it up to 100cm^3 with the same solvent.

(v) 50% aqueous NaOH solution: 50g NaOH dissolved and made up to 100cm^3 with distilled water.

(vi) Heavy magnessium oxide.

(vii) Chloroform.

(viii) Potassium sulphate

(ix) Mercuric Oxide.

(x) Sulphuric acid

All reagents except heavy magnessium oxide were of Analytical grade.

2.10.2 Method.

Accurately known weight of about 5g of each tea sample was extracted with 200cm^3 of water by boiling under reflux for 2 hours, in the presence of 10g heavy magnessium oxide. The extract was cooled, transfered to a 500cm^3 volumetric flask, made up to mark, mixed and filtered through a filter paper.

300cm^3 of the filtrate was evaporated to about 100cm^3 in the presence of 15cm^3 of 10 percent sulphuric acid. The solution was filtered into a separator through a filter paper. Both the flask and the filter paper were rinsed with 1 percent sulphuric acid. The caffeine was extracted with six successive portions of chloroform (25, 20, 15, 10, 10 and 10cm^3 portions). The combined chloroform extract was treated with 5cm^3 of 1 percent potassium hydroxide.

The chloroform was evaporated on a water bath in a pre-weighed flask and the residue dried at 100^{o}C.

This was weighed as crude caffeine and transfered to a kjeldahl digestion flask using small portions of concentrated sulphuric acid. 1.9g of potassium sulphate and 0.04g of mercuric oxide were added to the kjeldahl flask. The mixture was heated strongly until a clear colourless solution was obtained. The solution was then quantitatively transfered to a $100cm^3$ volumetric flask, made up to the mark and mixed. $10cm^3$ of this solution was transfered to a microkjeldahl apparatus. $10cm^3$ of 50% aqueous sodium hydroxide solution was added and the liberated ammonia was collected in $10cm^3$ of bromocresol green indicator in boric acid. The ammonia was then titrated with 0.01M hydrochloric acid.

According to Pearson (1976b),

$1cm^3$ 0.1M HCl $\equiv$ 4.855mg anhydrous caffeine.

So that $1cm^3$ 0.01M HCl $\equiv$ 0.4855mg anhydrous caffeine.

$$\text{Percent caffeine} = \frac{\text{Weight of caffeine}}{\text{Weight of sample in } 300cm^3 \text{ filtrate}} \times \frac{100}{1}$$

2.11 DETERMINATION OF CAFFEINE CONTENT OF COFFEE

(Coffee samples other than the instant coffee samples) (Pearson 1976b).

In this method, water extract of coffee is treated with zinc ferrocyanide clearing agents to clarify the solution.

The caffeine is then extracted into chloroform and its purity tested by determining the nitrogen content using the micro-kjeldahl method.

2.11.1 Reagents.

(i) Zinc acetate solution: prepared by dissolving 21.9g crystallised zinc acetate in 3cm^3 of glacial acetic acid in distilled water and diluting to 100cm^3.

(ii) Potassium ferrocyanide solution: prepared by dissolving 10.6g potassium ferrocyanide in distilled water. This solution and zinc acetate solution in equal volumes make the zinc ferrocyanide clearing agents.

(iii) 0.88 Ammonia

(iv) Chloroform analar grade

(v) Sulphuric acid about 98%

(vi) Potassium Sulphate

(vii) Mercuric oxide

(viii) 2 percent boric acid with 0.1 percent bromocresol green indicator: prepared by dissolving 2g of boric acid plus 0.1g of bromocresol green indicator in distilled water and making it up to 100cm^3.

(ix) 1M sodium hydroxide: prepared by dissolving 4g Sodium hydroxide pellets in distilled water and making it up to 100cm^3

2.11.2 Method:

Accurately known weight (about 10g) of each ground roasted coffee sample was extracted with 400cm^3 boiling water for 5 hours under reflux. The extract was concentrated by evaporation to about 85cm^3 and transfered to a 100cm^3 standard flask. 5cm^3 each of the zinc ferrocyanide clearing agents were added. The solution was made up to mark, mixed and filtered through a filter paper. The volume of the filtrate was measured. It was then transfered into a separator. 10cm^3 0.88 ammonia was added and the mixture shaken with five 25cm^3 portions of chloroform. The bulk extract was first shaken with 10cm^3 1M sodium hydroxide solution and then with 10cm^3 of water. The sodium hydroxide and the water extracts were shaken with a little chloroform and added to the bulk chloroform extract. The chloroform extract was filtered into a pre-weighed round-bottom flask and the chloroform evaporated on a water bath. The residue was dried at 100°C and weighed as crude caffeine. It was then transfered completely into a kjeldahl flask by small portions of concentrated sulphuric acid. The amount of caffeine was determined as previously described in section 2.10.2.

$$\text{Percent caffeine} = \frac{\text{weight of caffeine}}{\text{Weight of sample in filtrate}} \times \frac{100}{1}.$$

2.12. DETERMINATION OF CAFFEINE CONTENT OF INSTANT COFFEE SAMPLES. (Pearson, 1976b).

The procedure is slightly modified from that of ground roasted coffee in section 2.11.2. A known weight of each instant coffee, about 5g, was dissolved in a little hot water in a $100cm^3$ volumetric flask. $5cm^3$ of each of the zinc ferrocyanide clearing agents was added. The mixture was cooled, made up to the mark and filtered through a filter paper. The volume of the filtrate was measured and it was transferred into a separator. The caffeine was then extracted and determined as described in section 2.11.2.

$$\text{Percent caffeine} = \frac{\text{Weight of caffeine}}{\text{Weight of sample in filtrate}} \times \frac{100}{1}$$

2.13 DETERMINATION OF MINERAL ELEMENTS.

The ash in a tea sample contains mostly potassium and phosphorous (Pearson 1976a) while the coffee ash contains mostly potassium, phosphorous and magnessium (Winton and Winton 1939).

The analytical methods for the determination of these elements are based on colorimetry, photometry and atomic absorption spectrophotometry.

2.13.1 SAMPLE PREPARATION (Hanson 1973).

Accurately known quantity, of about 5g of each tea and coffee sample was ashed as in section 2.4 and the weight noted. $2cm^3$ of concentrated hydrochloric acid was added to the ash to dissolve it and a few drops of concentrated nitric acid were also added. The solution was boiled on a water bath and evaporated to dryness. The residue was extracted with distilled water, filtered through a filter paper and transfered quantitatively to a $100cm^3$ standard flask. It was then made up to mark and appropriate dilutions of this stock solution were made for the determination of potassium, phosphorous, calcium, magnessium and copper.

2.13.2 DETERMINATION OF POTASSIUM

The quantity of potassium in each of the samples was determined by flame photometry, (Pearson, 1976d). CORNING-EEL flame photometer was used.

In flame photometry the atoms are excited by flame and on returning to the ground state they emit radiation characteristic of the element concerned. The intensity of the radiation emitted is directly proportional to the concentration of the element present. A calibration curve is normally plotted and the concentration of the element in the sample is read from the curve after the intensity is known.

2.13.2.1 Reagents.

(i) Potassium stock solution: prepared by dissolving 5.779g potassium dihydrogen phosphate (Analar grade) in water and diluting to $1dm^3$.

(ii) Standard dilute potassium solution: prepared by diluting $50cm^3$ of the potassium stock solution to $1dm^3$ with distilled water (= $100mgdm^{-3}$ as K_2O).

2.13.2.2. Method

A series of solutions containing 10, 12, 14, 16, 18 and 20 $mgdm^{-3}$ K_2O were prepared from the freshly prepared standard dilute potassium solution. These were used to construct the calibration curve. The ash solution for each tea or coffee sample was diluted to approximately $15mgdm^{-3}$ K_2O. The actual concentration of K_2O in these samples were read from the calibration curve after measuring the emission using potassium filter. The amount in the ash solution was calculated.

Percent K_2O in ash (or sample) =

$$\frac{\text{amount of } K_2O \text{ in ash solution} \times 100}{\text{Weight of ash (or sample)} \quad 1}$$

Percent K in ash (or sample) =

$$\frac{\text{amount of } K_2O \text{ in ash solution} \times 0.83 \times 100}{\text{Weight of ash (or sample)} \quad 1}$$

2.13.3 DETERMINATION OF PHOSPHOROUS.

Phosphorous was determined by the vanado-molybdate colorimetric method (Pearson 1976d). The acid solution containing orthophosphate is treated with an acid reagent containing molybdic acid and vanadic acid. A stable orange - yellow coloured complex of vanadimolybdiphosphoric acid (H_3PO_4, VO_3, $11MoO_3$, nH_2O) is formed. Provided the light is monochromatic, satisfactory results can be obtained in the region 420-480nm (Donald et al, 1956).

2.13.3.1 Reagents.

(i) Vanadate-molybdate composite reagents: prepared by dissolving 20g ammonium molybdate in $400cm^3$ water. 1g ammonium vanadate was dissolved in $300cm^3$ boiling water and cooled. $140cm^3$ concentrated nitric acid was added gradually with stiring to the solution. The molybdate solution was then added to the acid - vanadate solution with stirring and diluted to $1dm^3$ with distilled water.

(ii) Stock Phosphorous solution: prepared by dissolving 3.834g potassium dihydrogen phosphate (Analar grade) in distilled water and diluting to $1dm^3$ ($\equiv 2000mgdm^{-3}$ P_2O_5).

(iii) Standard Phosphorous solution: $25cm^3$ of the stock phosphorous solution was diluted to $250cm^3$ ($\equiv 200mgdm^{-3}P_2O_5$).

(iv) 1:2 Nitric acid solution: prepared by adding $50cm^3$ nitric acid to $100cm^3$ distilled water.

(v) 0.88 Ammonia.

2.13.3.2 Method

A series of solutions containing 6, 10, 20, 40, 60, 80 and 100 $mgdm^{-3}$ P_2O_5 were prepared from the standard phosphorous solution. A few drops of ammonia were added and the solution was made just acid with the dilute nitric acid solution. The vanadate - molybdate reagent was added and the solutions allowed to stand for about 10 minutes. The absorbances were measured at 470nm on a CE 505 double beam ultraviolet spectrophotometer. The readings were then used to plot the calibration curve. The ash solution for each tea and coffee sample was similarly treated and the concentration read from the calibration curve after measuring the absorbance.

Percent P_2O_5 in ash (or sample) =

$$\frac{\text{amount of } P_2O_5 \text{ in ash solution}}{\text{Weight of ash (or sample)}} \times \frac{100}{1}$$

Percent P in ash (or sample) =

$$\frac{\text{amount of } P_2O_5 \text{ in ash solution} \times 0.87 \times 100}{\text{Weight of ash (or sample)} \quad 1}$$

2.13.4 DETERMINATION OF CALCIUM

Calcium, Magnessium and copper were estimated with atomic absorption spectrophotometer (Perkin-Elmer Model 306 with digital readout). In this method, a solution of the element of interest is passed into a cool flame where the bulk of the atoms remain in the ground state. Radiation of a characteristic wavelength from a hollow cathode discharge lamp is passed through the flame. The atoms absorb some of this radiation and become excited. The decrease in intensity of the radiation is then measured using a monochromator and a detector system. The extent of absorption is dependent on the number of atoms in the ground state and is thus a function of the concentration of the atoms. The decrease in intensity is therefore related to the concentration of the element in solution.

2.13.4.1 Reagents.

(i) Strontium chloride solution: prepared by dissolving 30.43g of strontium chloride in distilled water and making up to $1dm^3$. This gave 10,000 $mgdm^{-3}$. This was diluted down to 1500 $mgdm^{-3}$ by making up $75cm^3$ of the solution to $500cm^3$.

(ii) Standard Calcium stock solution A: prepared by dissolving 2.497g oven dried calcium carbonate in a few cm^3 of distilled water followed by $10cm^3$ concentrated hydrochloric acid.

The solution was warmed to dissolve all the calcium carbonate powder. 7.5cm^3 of the 1500mgdm^{-3} strontium chloride solution was added to the calcium carbonate solution and then made up to 1 dm^3 with distilled water. This gave 1000 mgdm^{-3} of calcium ions.

(iii) Standard calcium working Solution: 20cm^3 of solution A was diluted to 200cm^3 (100 mgdm^{-3}) (B). To each of six 100cm^3 volumetric flasks was added 0, 3, 6, 9, 12 and 15 cm^3 of solution B. The solutions were then made up to mark with distilled water to give 0, 3, 6, 9, 12 and 15 mgdm^{-3}.

2.13.4.2 Method,

The atomic absorption spectrophotometer was set up with a hollow cathode tube using the line at 422.7nm. The absorbances of standard calcium working solutions were measured and a calibration curve plotted. The concentration of calcium ions in the ash solution of the samples were determined after treating each sample solution with strontium chloride to eliminate interferences of other ions.

$$\text{Percent calcium} = \frac{\text{calcium in ash solution}}{\text{weight of sample ashed}} \times \frac{100}{1}.$$

2.13.5. DETERMINATION OF MAGNESSIUM

Magnessium was determined by atomic absorption spectrophotometry.

2.13.5.1 Reagents.

(i) Strontium chloride solution: prepared as in section 2.13.4.1

(ii) Stock magnessium solution: prepared by dissolving 1.0g of pure magnessium ribbon in $10cm^3$ concentrated hydrochloric acid. The solution was evaporated to almost dryness over water bath and extracted with distilled water. $7.5cm^3$ of $1500mgdm^{-3}$ strontium chloride solution was added and the solution diluted to $1dm^3$ in volumetric flask. The solution contained $1000mgdm^{-3}$ magnessium ions.

(iii) Standard dilute magnessium solutions: $10cm^3$ of the stock solution was diluted to $100cm^3$ to give $100mgdm^{-3}$ From this solution 0, 0.5, 1.0, 1.5, 2.0 and 2.5 cm^3 were pipetted into six $100cm^3$ volumetric flasks and made up to mark. They gave 0, 0.5, 1.0, 1.5, 2.0 and $2.5_{mgdm^{-3}}$ of magnessium ions respectively.

2.13.5.2. Method.

The magnessium ions in the standard dilute solutions were determined at 285.2nm. $7.5cm^3$ of $1500mgdm^{-3}$ strontium chloride was added to the ash solutions of the samples during dilution to block interferences due to aluminium, silicon and sulphate ions. The absorbances of the solutions were read at the same wavelength and the concentration of magnessium ions determined from the standard curve.

$$\text{Percent magnessium} = \frac{\text{Magnessium in ash solution}}{\text{weight of sample ashed}} \times \frac{100}{1}$$

2.13.6 DETERMINATION OF COPPER

Copper was determined by atomic absorption spectrophotometry. See section 2.13.4 for details.

2.13.6.1 Reagents.

(i) Stock copper solution: prepared by dissolving 1.0g of pure copper metal in $5cm^3$ concentrated nitric acid and $5cm^3$ concentrated hydrochloric acid. The solution was evaporated to almost dryness and extracted with distilled water. It was then transfered into a $1000cm^3$ volumetric flask and made up to mark with distilled water. This solution contained $1000mgdm^{-3}$ copper ions.

(ii) Dilute standard copper solutions: To a set of six $100cm^3$ volumetric flasks were added 0. 0.5, 1, 2, 4 and $8cm^3$ of the stock solution. The solutions were then made up to mark with distilled water. They contained 0, 5, 10, 20, 40 and 80 $mgdm^{-3}$ of copper ions respectively.

2.13.6.2 Method.

Copper ions in the standard dilute solutions absorbed at a wavelength of 324.7nm and the calibration curve plotted. The absorbances of the ash solutions of the samples were read at the same wavelength and the concentrations of copper ions determined from the standard curve.

$$\text{Percent copper} = \frac{\text{Copper in ash solution}}{\text{Weight of sample ashed}} \times 100.$$

2.14 TOTAL NITROGEN DETERMINATION

Tea leaves and ground roasted coffee beans contain nitrogeneous matter which includes protein, caffeine and other N-containing compounds (Pearson, 1976a &b, Winton and Winton, 1939). The total nitrogen content was determined by the micro-kjeldahl method. This method involves the conversion of the nitrogen in the sample to ammonium salt by digestion involving acid hydrolysis.

2.14.1. Reagents.

(i) Sulphuric acid about 98 percent.

(ii) Potassium sulphate

(iii) Mercuric oxide

(iv) 2 percent boric acid with 0.1 percent bromocresol green indicator: prepared by dissolving 2g of boric acid plus 0.1g of bromocresol green indicator in distilled water and making up to $100cm^3$.

(v) 50 percent aqueous sodium hydroxide solution: prepared by dissolving 50g sodium hydroxide pellets and making up to $100cm^3$.

(vi) 0.1M Hydrochloric acid.

2.14.2 Method.

About 0.5g of each dried sample was accurately weighed and transfered into dried kjeldahl flasks. 1.9g potassium sulphate, 0.04g Mercuric oxide and $20cm^3$ sulphuric acid were added to the flask.

The mixture was heated strongly until a clear colourless solution was obtained. The solution was quantitatively transfered to a $100cm^3$ volumetric flask, made up to mark with distilled water and mixed. $10cm^3$ of this solution was transfered to a microkjeldahl apparatus. $10cm^3$ of 50 percent aqueous sodium hydroxide solution was added and the liberated ammonia collected in $10cm^3$ of bromocresol green indicator in boric acid. The ammonia was then titrated with 0.1M hydrochloric acid.

Each $1cm^3$ of 0.1N acid neutralised by the ammoniacal mixture corresponds to 0.0014g of Nitrogen (Pearson, 1976c).

Total nitrogen = Volume of 0.1N acid neutralised by $10cm^3$ of ammoniacal mixture X 10 X 0.0014g.

$$\text{Percent total nitrogen} = \frac{\text{Total nitrogen}}{\text{Weight of sample}} \times 100.$$

2.15 PETROLEUM-ETHER EXTRACT DETERMINATION. (Pearson, 1976a)

Ether-soluble compounds are extracted into light petroleum ether in a soxhlet continuous extraction apparatus. The compounds include free fats, oils and other non-fatty ether-soluble compounds. The fat estimate can be made by either evaporating off the ether and recording the weight of the extract or by noting the loss in weight of the moisture-free sample after extraction.

2.15.1 Reagents.

Light petroleum ether of boiling range 40-60^{o}C.

2.15.2 Method.

Accurately known weights of each dried sample (about 2g) was put in a pre-weighed thimble and the soxhlet extraction apparatus set up. The extraction was carried on continuously for about 15 hours with 300cm^{3} of light petroleum ether (40-60^{o}C). After the extraction the thimble with the sample inside it was removed and dried at 100^{o}C. It was allowed to cool and the weight taken. The difference in weight of the thimble and sample before and after the extraction was taken as the weight of substance extracted from the sample.

$$\text{Percent ether extract} = \frac{\text{Loss in weight of thimble plus sample before and after extraction}}{\text{Weight of dried sample taken}} \times 100$$

2.16. ORGANIC MATTER DETERMINATION

The total organic matter in the tea and coffee samples was determined by difference. The ash content of the dry sample was subtracted from the dry weight to give the organic matter content.

Percent total organic matter = 100-percent ash content.

CHAPTER III

RESULTS AND DISCUSSION

3.1. MOISTURE CONTENT.

The result of the moisture content determination of the samples are shown in Table 1 (a and b). The moisture content of the tea samples ranges from 6.94 percent to 11.49 percent. Breakdown of the result shows that the imported tea samples have a moisture content ragge of 6.94 percent to 11.49 percent while the ones blended and packed in Nigeria have between 7.88 and 8.46 percent.

For the coffee samples the moisture content is between 2.79 and 6.74 percent which on breakdown shows that the instant coffees have moisture content of 2.79 and 6.74 percent. The non-instant ones, that is, the ground roasted coffee samples have between 3.34 and 4.82 percent.

The moisture content is frequently an index of stability and quality. It is also a measure of yield and quantity of food solids. Advantage is taken of the possibilities of increasing storage stability by decreasing available water content in the preservation of foods and food products by drying and dehydration. Control of moisture content during preparation and storage is therefore necessary. Because of this, ground coffee and instant coffee are often packed under vacuum hence their low moisture content.

TABLE 1.

MOISTURE DETERMINATION

Percentage moisture content of the tea (a) and coffee (b) samples.

Table 1a.

Sample	Moisture content in percentage
T_1	11.49 ± 0.02
T_2	6.94 ± 0.13
T_3	8.10 ± 0.01
T_4	7.88 ± 0.12
T_5	8.46 ± 0.02

Table 1b.

Sample	Moisture content in percentage
C_1	6.74 ± 0.02
C_2	4.82 ± 0.07
C_3	2.79 ± 0.10
C_4	3.34 ± 0.05
C_5	3.90 ± 0.11

According to Pearson, (1976a,b) a good quality tea seldom has a moisture content in excess of 7 percent and that of the coffee samples 5 percent.

On performing t-test analyses on the results it was observed that the moisture content of most of the tea samples analysed are significantly in excess of the value recommended by Pearson (1976a) ($p<0.05$). Only T_2 has a moisture content of 6.94 percent which is not significantly different ($p>0.05$) from the literature value. This may indicate that the other samples T_1, T_3, T_4 and T_5 would not store for a long time before producing musty infusion. On applying the same test to the coffee samples it was found that only one sample C_1, has moisture content significantly in excess of the recommended value of 5 percent ($p<0.05$). Such a coffee may go stale within a short period. The other coffee samples C_2, C_3, C_4 and C_5 are not significantly different from the literature value ($p>0.05$).

Comparing the percent moisture of coffee to tea, tea samples seem to have higher moisture contents. This is because the coffee samples are packed under vacuum after grinding to reduce deterioration. This also explains why coffee samples are packed in tins of tight-fitting lids. The tea samples on the other hand, are packed in paper packets.

3.2 ASH CONTENT

3.2.1 Total ash.

The results of the ash content determination are shown in Table 2. (a and b). From Table 2a it could be seen that the total ash contents of the different tea samples range between 5.67 and 6.57 percent. Pearson (1976a) suggested that the total ash content of tea should preferably not exceed 7 per cent. All the tea samples analysed have their percentage total ash content not significantly different from the literature value. ($p>0.05$).

It could also be seen from Table 2b that the total ash content of the different coffee samples range between 4.13 and 9.00 percent. The instant coffee samples C_1 and C_3 have the highest percentage total ash contents of 9.00 and 7.97 percent while the other ground roasted coffees have their total ash content between 4.05 and 4.14 percent. From the analyses by Clifford (1975), Joslyn (1963) and Winton and Winton (1939), the total ash of ground roasted coffee lies between 3.40 and 4.90 percent. Pearson (1976b) further gave the range of total ash for instant coffees as 7-14 percent. Both the instant coffee samples and the ground roasted coffee samples analysed lie within these ranges.

Though the ash of a foodstuff is the inorganic residue remaining after the organic matter has been burnt away, the

TABLE 2. ASH DETERMINATION

Total ash and water-soluble ash of tea(a) and coffee(b) samples.

Table 2a

Sample	% Total ash	% Water-soluble ash
T_1	5.67 ± 0.39	3.12 ± 0.43
T_2	6.57 ± 0.01	3.78 ± 0.26
T_3	6.12 ± 0.03	3.24 ± 0.17
T_4	6.08 ± 0.03	3.39 ± 0.23
T_5	6.05 ± 0.01	3.25 ± 0.30

Table 2b

Sample	% Total ash	% Water-soluble ash
C_1	9.00 ± 0.04	5.81 ± 0.27
C_2	4.14 ± 0.02	2.52 ± 0.17
C_3	7.97 ± 0.01	3.21 ± 0.28
C_4	4.05 ± 0.01	1.22 ± 0.12
C_5	4.13 ± 0.24	1.42 ± 0.22

ash obtained is not necessarily of exactly the same composition as the mineral matter present in the original food. This is because there may be losses due to volatilisation or some interaction between constituents. The ash figure can be regarded as a general measure of quality (Jacobs, 1962). It may also be helpful in determining not only the total ash but also the ash soluble and insoluble in water and the alkalinity of the soluble ash. Ashing is also necessary in the preparation of food products for analysis of naturally occuring minerals or metallic salts present as contaminants. As a measure of quality it has been found, (Jacobs 1962), that in many teas the ash is between 5 and 6 percent while in faced teas, (that is teas with leaves and/or stalks other than the tea leaves and stalks), the proportion of ash may be as high or higher than 10 percent. In "lie-tea" (i.e. false teas), the proportion may reach 30 percent. In spent or exhausted tea, however, the ash drops below 3 percent. The same measure of quality applies to the coffee ash too.

3.2.2 Water-soluble ash.

The water-soluble ash content of the samples analysed is given also in Table 2 (a&b). As noted earlier, ash is a measure of quality. In genuine tea about 50 percent of the ash is water soluble, (3 to 3.5 percent of sample).

In exhausted teas however it drops to about 0.5 percent (Jacobs, 1962). This is because a low water soluble ash indicates previous abstraction of constituents probably during "instant" tea manufactures, with consequent lowering of quality. The tea samples with water soluble ash ranging from 3.12 to 3.78 of the samples agree with the range of values given by Jacobs (1962) and quoted above.

From the analyses recorded by Clifford (1975) the water soluble ash of ground roasted coffee is between 65 - 85 per cent of total ash, that is, in the range of 3.0 to 3.6 percent of sample. The corresponding values for the instant coffees are however not given. The ground roasted coffee samples analysed have water soluble ash between 1.22 and 2.52. These values are lower than the literature value.

It could be seen from Tables 3a and b that the water soluble ash of the tea samples as percentage of the total ash range between 52.78 and 57.53 percent. These figures are not significantly different ($p > 0.05$) from the literature value of 50 percent. The imported samples, T_1 and T_2 compare favourably well with T_3, T_4 and T_5 which are processed in the country. For the coffee samples however, the water soluble ash range between 30 and 65 percent of the total ash. Only C_1 and C_2 with 64.56 and 60.87 percent have values not significantly different ($p > 0.05$) from the literature value of 65 percent.

TABLE 3: WATER-SOLUBLE ASH DETERMINATION

Water-soluble ash as percentage of total ash of the tea(a) and coffee(b) samples.

Table 3a

Sample	Water-soluble ash as percentage of total ash
T_1	55.03 ± 3.74
T_2	57.53 ± 3.87
T_3	52.78 ± 2.92
T_4	55.76 ± 4.06
T_5	53.72 ± 4.92

Table 3b

Sample	Water-soluble ash as percentage of total ash
C_1	64.56 ± 3.29
C_2	60.87 ± 4.28
C_3	40.33 ± 3.46
C_4	30.12 ± 2.92
C_5	34.38 ± 3.34

C_3, C_4 and C_5 with 40.33, 30.12 and 34.38 percent of soluble ash respectively, have values that are significantly lower ($p<0.05$) than that from literature. This may be an indication that most of the inorganic constituents of the samples are insoluble in water and so can not be extracted into hot water during infusion (that is when the coffee beverage is being made). It may probably also mean that the coffee beans were mixed with flavourings which have ashes of lower solubility than coffee.

3.2.3 Alkalinity of soluble ash.

The alkalinity of the soluble ash is given in Table 4. The alkalinity is useful for the detection of the presence of exhausted tea leaves or coffee beans (Jacobs 1962). It is expfessed in many ways (Pearson 1976c). For easy comparison with the literature the values are here expressed as K_2O for the tea samples, K_2CO_3 for the ground roasted coffee samples, and volume of 0.1N acid per gram of sample for the instant coffee samples. A low alkalinity of the ash indicates previous abstraction of important constituents with consequent lowering of quality.

Pearson (1976 a,b) and Clifford (1975) recorded the following ranges of values: 1.20 to 2.00 percent as K_2O for the tea samples, 1.90 to 3.20 percent as K_2CO_3 for the ground roasted coffee samples and 8-14cm^3 0.1N acid per g for the

TABLE 4: ALKALINITY OF SOLUBLE ASH DETERMINATION

Percentage alkalinity of soluble ash of the tea(a) and coffee (b) samples.

Table 4a.

Sample	% Alkalinity (as K_2O)
T_1	1.41 ± 0.07
T_2	1.50 ± 0.09
T_3	1.30 ± 0.07
T_4	1.29 ± 0.07
T_5	1.34 ± 0.07

Table 4b.

Sample	% Alkalinity (as K_2CO_3)
C_1	*5.23 ± 0.06
C_2	1.28 ± 0.28
C_3	*2.91 ± 0.30
C_4	0.86 ± 0.02
C_5	0.92 ± 0.16

* Alkalinity as volume of 0.1N acid per gram of sample.

instant coffees.

It could be seen from the results in Table 4 that for the tea samples, the alkalinity ranges from 1.29 to 1.50 percent as K_2O. These fall in the ranges given by Pearson (1976a) and quoted above. The instant coffee samples, C_1 and C_3 have alkalinity of 5.23 and 2.91 0.1N acid per gram respectively. These are however lower than the literature value. C_2 C_4 and C_5 have alkalinity of 1.28, 0.86 and 0.92 respectively. C_2 and C_5, both french coffees, are not significantly different ($p>0.05$) from the literature value taken as 1.90. C_4 however has a lower alkalinity. This may be due to the type of treatment (dry method of curing) it underwent during processing.

3.3 WATER EXTRACTIVES.

The results of the determinations of water extractives of the tea and coffee samples are given in Table 5 (a and b). It could be seen from Table 5a that the percent water extractive for the tea samples range from 36.79 to 42.35. These values fall within the 35.50-46.40 percent range given in literature (Pearson, 1976a). T_2 and T_5 have the highest values of 42.35 and 42.34 percent respectively. T_3 has the lowest value of 36.79 percent while T_1 and T_4 have 40.88 and 40.86 percent respectively.

TABLE 5. WATER EXTRACTIVES DETERMINATION

Percentage water extractives of the tea(a) and coffee(b) samples.

Table 5a

Sample	% Water extractive
T_1	40.88 ± 0.52
T_2	42.35 ± 0.62
T_3	36.79 ± 1.35
T_4	40.86 ± 0.38
T_5	42.34 ± 0.12

Table 5b

Sample	% Water-extractive
C_2	46.03 ± 0.31
C_4	31.85 ± 0.50
C_5	37.47 ± 0.13

The imported tea samples, T_1 and T_2, are not significantly different from the others processed and packed in the country. The percentage water extractive may however depend on the locality of the tea. Manley, (1965) has stated that most Indian teas give 35.50-46.40 percent extractives while China teas give lower figures ranging from 29.60 to 41.40 percent.

From Table 5b it could be seen that the three coffee samples analysed have between 31.85 and 46.03 percent water extractives. C_2 and C_5, the french coffees, have the highest values of 46.03 and 37.47 percent respectively. C_4 has a water extractive of 31.85 percent. It has been found that most of the coffee adulterants, like chicory, have considerably higher water extracts than coffee (Pearson, 1976b). Roasted chicory has a solubility of about 70 percent in hot water while roasted coffee has just between 23 and 33 percent. This probably explains why C_2 and C_5, which are mixtures of coffee and chicory, have higher water extractives than C_4 which is purely coffee. C_4 however has a water extractive that lies in the range given by literature.

The water soluble solids are determined and used as criteria of quality. In tea and coffee beverages these solids represent the palatable part of these beverages. Very low water extractives is an indication of previous abstraction.

3.4 TANNIN CONTENT

The tannin content of the samples are given in Table 6. For the tea samples the values range between 9.08 and 14.25 percent. T_1 has the highest value of 14.25 percent followed by T_3 with 11.84 percent. T_2 has the lowest tannin content of 9.08 percent. T_4 and T_5 have the same value of 9.89 percent. These values fall in within the range of 7.30–15.10 percent given by Pearson, (1976a). The tannin contents of the coffee samples range between 13.73 and 5.25 percent. The instant coffees, C_1 and C_3 have the highest tannin contents of 9.46 and 13.73 percent respectively. This is not unexpected because the instant coffees were almost completely soluble in hot water whereas the ground roasted coffee beans contained a fairly large proportion of insoluble matter that had to be discarded after infusion. Samples C_2, C_4 and C_5 have 5.96, 5.25 and 6.27 percent tannin respectively. Clifford, (1975) reported the average tannin content in coffee as 4.6 percent. The tannin content of the coffee samples analysed are likely to fall within the range, though this is not given.

3.5 CAFFEINE CONTENT

Table 7 shows the caffeine contents of the tea and coffee samples.

TABLE 6: TANNIN CONTENT DETERMINATION

Percentage tannin for the tea(a) and coffee(b) samples.

Table 6a

Sample	% Tannin
T_1	14.25 ± 1.25
T_2	9.08 ± 0.80
T_3	11.84 ± 0.85
T_4	9.89 ± 1.05
T_5	9.89 ± 0.95

Table 6b

SAMPLE	% TANNIN
C_1	9.46 ± 0.89
C_2	5.96 ± 0.72
C_3	13.73 ± 1.20
C_4	5.25 ± 0.78
C_5	6.27 ± 0.66

TABLE 7: CAFFEINE CONTENT DETERMINATION

Percentage caffeine of the tea(a) and coffee(b) samples.

Table 7a

Sample	% Caffeine
T_1	1.88 ± 0.05
T_2	1.94 ± 0.06
T_3	1.53 ± 0.01
T_4	1.38 ± 0.11
T_5	1.48 ± 0.05

Table 7b

Sample	% Caffeine
C_1	2.15 ± 0.13
C_2	0.71 ± 0.02
C_3	3.35 ± 0.02
C_4	0.68 ± 0.03
C_5	0.73 ± 0.02

The tea samples (Table 7a) have an average percentage caffeine content of 1.64 percent ranging from 1.38 to 1.94 percent. Samples T_1 and T_2, the imported teas, have the highest values of 1.88 and 1.94 percent which have an average of 1.91 percent. Also, T_3, T_4 and T_5 contain 1.53, 1.38 and 1.48 percent caffeine respectively with an average of 1.46 percent. These samples, T_3, T_4 and T_5 have lower caffeine contents than the literature value given as between 1.9 and 3.6 percent by Pearson (1976a) and as 2.7 to 4.1 percent by Kaplan et al (1974). Samples T_1 and T_2 have higher caffeine contents than T_3, T_4 and T_5, and may make more stimulating drinks or infusions.

The caffeine contents of the coffee samples (Table 7b) analysed range between 0.68 and 3.35 per cent. Samples C_1 and C_3, the instant coffees, have the highest caffeine contents of 2.15 and 3.35 percent respectively. The literature value is given as between 2.00-8.00 percent (Pearson, 1976b). It could be seen that the instant coffee samples analysed fall within the literature value. The ground roasted coffee samples C_2, C_4 and C_5 contain 0.71, 0.68 and 0.73 percent caffeine respectively. These are not significantly different from literature values. According to Kaplan et al (1974) the caffeine content of freshly ground roasted coffee range between 0.80 and 1.80 percent.

Clifford (1975) found that the caffeine content range between 0.90 and 1.80 percent. However, variations are known to occur depending on the species.

3.6. MINERAL CONTENT

The main constituents of the ash of tea are potassium and phosphorous. And on this fact, claims have been made that the beverage may alleviate acidosis in the system and reduce the tendency to gout (Harler, 1963b). According to Winton and Winton (1939) the major constituents of ash of roasted coffee are potassium, phosphorous and magnessium. The elements determined in this study are potassium, phosphorous, calcium, magnessium and copper.

3.6.1 Potassium.

The potassium content of the tea and coffee samples are shown in Table 8 (a and b). It could be seen from Table 8a that for the tea samples, the percent K_2O in ash ranges between 33.98 and 39.47 percent. Sample T_4 has the highest value of 39.47 percent while T_1 has the lowest value of 33.98 percent. Samples T_2, T_3 and T_5 have 38.28, 36.33 and 38.05 percent respectively. Pearson (1976a) gave the percentage of K_2O in tea ash as between 27 to 36 percent. It could then be seen that while the other samples fall in within the

TABLE 8: DETERMINATON OF POTASSIUM

Percentage potassium in the tea(a) and coffee(b) samples.

Table 8a

Sample	% K_2O in ash	% K in sample
T_1	33.98 ± 0.99	1.83 ± 0.05
T_2	38.28 ± 0.40	1.89 ± 0.02
T_3	36.33 ± 0.43	1.82 ± 0.02
T_4	39.47 ± 0.40	1.95 ± 0.02
T_5	38.05 ± 0.21	1.86 ± 0.01

Table 8b

Sample	% K_2O in ash	% K in sample
C_1	53.39 ± 0.76	3.92 ± 0.06
C_2	45.43 ± 0.32	1.79 ± 0.01
C_3	49.78 ± 0.53	3.52 ± 0.04
C_4	40.94 ± 0.34	1.72 ± 0.02
C_5	40.98 ± 0.32	1.61 ± 0.01

literature value T_2, T_4 and T_5 are slightly above. The percentage potassium in the samples are also given in the table. They lie within the range 1.82-1.95 percent. There seems not to be much difference between potassium contents of all the tea samples analysed.

The coffee samples have K_2O content of between 40.94 and 53.39 percent in their ashes as could be seen from Table 8b. Samples C_1 and C_3 have the highest values of 53.39 and 49.78 percent respectively. C_4 and C_5 have 40.94 and 40.98 respectively. The difference between C_4 and C_5 is not much. C_2 has a value of 45.43 percent. The percentage potassium in the samples is also shown in the table. This range between 1.61 and 3.92 percent. The instant coffees, C_1 and C_3 have the highest values of 3.92 and 3.52 percent respectively. The values of C_2, C_4 and C_5 are not very different from each other.

3.6.2 Phosphorous.

The P_2O_5 content of the ashes of the tea samples are given in Table 9a. The percentage P_2O_5 ranges between 9.90 and 12. 38 percent. T_3 has the lowest value of 9.90percent while T_4 has the highest of 12.38 percent. Samples T_1, T_2 and T_5 have the values of 11.37, 11.57 and 10.64 percent respectively.

TABLE 9: DETERMINATION OF PHOSPHOROUS

Percentage phosphorous in the tea(a) and coffee(b) samples.

Table 9a

Sample	% P_2O_5 in ash	% P in sample
T_1	11.37 ± 0.10	0.64 ± 0.01
T_2	11.57 ± 0.02	0.60 ± 0.01
T_3	9.90 ± 0.03	0.52 ± 0.01
T_4	12.38 ± 0.03	0.64 ± 0.01
T_5	10.64 ± 0.10	0.55 ± 0.01

Table 9b

Sample	% P_2O_5 in ash	% P in sample
C_1	7.86 ± 0.08	0.61 ± 0.01
C_2	9.99 ± 0.08	0.41 ± 0.01
C_3	9.25 ± 0.02	0.69 ± 0.01
C_4	7.67 ± 0.08	0.34 ± 0.01
C_5	7.85 ± 0.09	0.32 ± 0.01

They are lower than the range of 14-18 percent given by Pearson, (1976a). The percentage of phosphorous in each of the samples is also given in Table 9a. It ranges between 0.52 and 0.64 percent. T_3 has the lowest value of 0.52 percent while T_1 and T_4 each has a value of 0.64 percent. Samples T_2 and T_5 have 0.60 and 0.55 percent respectively. The mean of the phosphorous content of the imported tea samples T_1 and T_2 is 0.62 percent while that of the other tea samples processed in Nigeria is 0.57 percent. It could be seen then that there is not much difference between these samples.

The P_2O_5 content of the ashes of the coffee samples are shown in Table 9b. The P_2O_5 content ranges from 7.67 percent to 9.99 percent. The values for C_4 and C_2 being the lowest and the highest respectively. Samples C_1, C_3 and C_5 have 7.86, 9.25 and 7.85 percent respectively. The phosphorous content of the samples is shown alongside the P_2O_5 content in Table 9b. The value ranges between 0.32 and 0.69 percent. The instant coffees, C_1 and C_3 have the highest values of 0.61 and 0.69 percent respectively and these compare favourably with each other. C_2 and C_4, the french coffee samples, also have 0.41 and 0.34 percent respectively. Also the difference between them is not much. C_5, the turkish blend coffee has 0.32 percent which is not very different from those of the french coffee samples.

TABLE 10: CALCIUM DETERMINATION

Percentage calcium in the tea(a) and coffee(b) samples.

Table 10a

Sample	% Ca in sample
T_1	0.46 ± 0.02
T_2	0.45 ± 0.06
T_3	0.50 ± 0.08
T_4	0.49 ± 0.03
T_5	0.44 ± 0.05

Table 10b

Sample	% Ca in sample
C_1	0.18 ± 0.01
C_2	0.20 ± 0.01
C_3	0.15 ± 0.01
C_4	0.26 ± 0.01
C_5	0.30 ± 0.02

3.6.3 Calcium.

Table 10a shows the calcium content of the tea samples. The values range between 0.44 and 0.50 percent. T_5 has the least value while T_3 has the highest. It could be seen from the table that the amount of calcium in all the tea samples is roughly the same.

Table 10b shows the values for the coffee samples. The instant coffees C_1 and C_3 have the smallest values of 0.18 and 0.15 percent respectively. The other coffee samples C_2, C_4 and C_5 have 0.20, 0.26 and 0.30 percent calcium respectively.

It could be seen, generally, that the tea samples have higher calcium content than the coffee samples.

3.6.4 Magnessium.

The magnessium content of the tea samples are shown in Table 11a. All the samples have roughly the same values of 0.21 to 0.22 percent except T_1 which has a slightly higher value of 0.25 percent.

Table 11b gives the magnessium content of the coffee samples. C_1 and C_3, the instant coffees, have the highest values of 0.39 and 0.35 percent respectively while C_2 has the least value of 0.15 percent. The other samples C_4 and C_5 have roughly the same values.

TABLE 11: MAGNESSIUM DETERMINATION

Percentage magnessium in the tea(a) and coffee(b) samples.

Table 11a

Sample	% Mg in sample
T_1	0.25 ± 0.01
T_2	0.21 ± 0.02
T_3	0.22 ± 0.03
T_4	0.21 ± 0.02
T_5	0.21 ± 0.01

Table 11b

Sample	% Mg in sample
C_1	0.39 ± 0.01
C_2	0.15 ± 0.01
C_3	0.35 ± 0.04
C_4	0.28 ± 0.03
C_5	0.25 ± 0.03

TABLE 12: COPPER DETERMINATION

Percentage copper in the tea(a) and coffee(b) samples.

Table 12a

Sample	% Cu in sample X 10^{-3}
T_1	2.77 ± 0.39
T_2	2.50 ± 0.18
T_3	1.80 ± 0.45
T_4	2.37 ± 0.35
T_5	2.22 ± 0.42

Table 12b

Sample	% Cu in sample X 10^{-3}
C_1	0.89 ± 0.51
C_2	0.87 ± 0.87
C_3	0.07 ± 0.07
C_4	0.09 ± 0.09
C_5	0.61 ± 0.31

3.6.5 Copper.

Table 12 shows the copper contents of the tea and coffee samples. These values are very small. Indeed, for the coffee samples it seems as if the copper content is negligible. In the tea samples the copper content range between 2.7×10^{-3} and 1.8×10^{-3} percent. These low values of copper may indicate the absence of copper adulteration.

3.7. TOTAL NITROGEN CONTENT

The results of the total nitrogen determination is shown in Table 13. The total nitrogen includes the nitrogen due to protein, caffeine, nucleic acids and other N-containing compounds. The total nitrogen content of the dry tea samples is shown in Table 13a. The values range between 4.03 and 4.57 percent. T_4 has the highest value while T_3 has the lowest. T_2 and T_5 have 4.53 and 4.48 percent respectively. These values are below the range of values quoted by Pearson, (1976a) as between 5.00 and 6.20 percent. This may probably indicate that the tea samples analysed here have lower nitrogen containing compounds than the samples analysed, by Pearson (1976a). The reason for this may be due to difference in species.

The results for the coffee samples are shown in Table 13b.

TABLE 13: TOTAL NITROGEN DETERMINATION.

Percentage total nitrogen in the tea(a) and coffee(b) Samples.

Table 13a

Sample	% Total nitrogen
T_2	4.53 ± 0.09
T_3	4.03 ± 0.02
T_4	4.57 ± 0.05
T_5	4.48 ± 0.05

Table 13b

Sample	% Total nitrogen
C_1	2.93 ± 0.01
C_2	1.86 ± 0.01
C_3	3.49 ± 0.15
C_4	2.01 ± 0.02
C_5	1.84 ± 0.01

The instant coffees, C_1 and C_3 have the highest values of 2.93 and 3.49 percent respectively. C_2 and C_5 have the lowest values of 1.86 and 1.84 percent respectively while C_4 has 2.01 percent. Except for C_4, the other ground roasted coffee samples have lower total nitrogen content than the values quoted by Pearson (1976b) as between 2.10 and 3.30 percent. Again, the difference may be due to specie differences.

3.8 ETHER EXTRACT DETERMINATION.

The results of the ether-extract determinations are shown in Table 14. Table 14a gives the values for the tea samples. The percent ether extract ranges between 10.87 and 10.37. T_5 has the highest value while T_2 has the lowest. T_3 and T_4 have 10.55 and 10.66 respectively. All the tea samples have ether extracts falling within the range given by Pearson, (1976a as between 10 and 11 percent.

It could be seen from Table 14b for the coffee samples that ether extract ranges between 14.90 and 9.94. The instant coffees C_1 and C_3 have 14.23 and 9.48 percent respectively. The other ground roasted coffee C_2, C_4 and C_5 have 10.12, 14.90 and 9.94 percent respectively. These values agree with the range quoted by Pearson (1976b) as between 8.00 and 14.20 percent.

TABLE 14: ETHER EXTRACT DETERMINATION

Percentage ether extract determination in the tea(a) and coffee(b) samples.

Table 14a

Sample	% Ether extract
T_2	10.37 ± 0.98
T_3	10.55 ± 0.50
T_4	10.66 ± 0.31
T_5	10.87 ± 0.63

Table 14b

Sample	% Ether extract
C_1	14.23 ± 0.72
C_2	10.12 ± 0.35
C_3	9.48 ± 0.42
C_4	14.90 ± 0.60
C_5	9.94 ± 0.30

TABLE 15: TOTAL ORGANIC MATTER DETERMINATION (BY DIFFERENCE).

Percentage total organic matter in the tea and coffee samples.

Table 15a

Sample	% Total organic matter
T_1	94.33 ± 0.64
T_2	93.43 ± 0.01
T_3	93.89 ± 0.03
T_4	93.92 ± 0.03
T_5	93.96 ± 0.01

Table 15b

Sample	% Total organic matter
C_1	91.00 ± 0.04
C_2	95.86 ± 0.02
C_3	92.04 ± 0.01
T_4	95.95 ± 0.01
T_5	95.87 ± 0.24

3.9 TOTAL ORGANIC MATTER CONTENT

The results of the organic matter content is shown in Table 15. From Table 15a it could be seen that total organic matter ranges from 93.43 to 94.33 percent. These values are quite close and it may therefore be concluded that the tea samples have fairly the same organic matter content.

From Table 15b it could be seen that the total organic matter ranges from 91.00 and 95.95 percent.

COMPARISON OF SAMPLES.

The samples analysed are paired up as shown below and compared.

T_1 and T_5.

T_1 is a Lyon tea. It is imported into Nigeria from British Isles. T_5 is a CTC Lipton tea processed in Nigeria. Both T_1 and T_5 are in tea bags. T_1 has higher moisture content, tannin, caffeine and phosphorous. It however has lower water extractive, ash, water soluble ash. It could then be seen that T_1 is more liable to go mouldy with time than T_5 and T_5 gives more water-soluble solids when infused. T_5 also has a higher and soluble mineral contents.

T_2 and T_5.

T_2 is CTC Lipton tea made in London. T_5 is also a CTC Lipton tea but made in Nigeria. Both are in tea bags or satchets. For the same quantity, T_5 is half the price of T_2. T_2 has a higher ash content, water soluble ash and caffeine content. They both have the same percentage water extractive and there is not much difference in their potassium, phosphorous, calcium and magnessium contents. T_2 has a lower moisture content and lower tannin. It could be seen that T_2 has a higher storage stability and slightly higher mineral content.

T_2 also has a higher caffeine content hence it may be more stimulating than T_5. T_5 is however cheaper than T_2 by 50 percent. It is therefore suggested that for good keeping properties the moisture content of T_5 be kept low.

T_3 and T_5.

T_3 is Lipton tea. The leaves are packed in polythene bags. T_5 is a CTC Lipton tea packed in satchets. Both T_3 and T_5 are made in Nigeria. T_3 co sts ₦7.50 per kilogramme while T_5 costs ₦12.50 for the same weight. T_3 has a higher tannin content than T_5. T_3 has a lower water extractive and slightly lower moisture content. The caffeine content, ash content and water soluble ash are about the same.

T_3 and T_4.

T_3 is Lipton tea. The leaves are packed in polythene bags. T_4 is also a Lipton tea packed in polythene bags. T_3 costs ₦7.50 per kilogramme while T_4 costs ₦6.00. T_3 has a slightly higher moisture content, tannin and slightly higher caffeine than T_4. T_3 has a lower water extractive and water-soluble ash. The ash content and the potassium calcium, magnessium and phosphorous content are almost the same.

It could be inferred that T_4 gives more water soluble solids and minerals than T_3.

C_1 and C_3.

C_1 is a Hill Bros instant coffee imported from U.S.A. C_3 is a Nescafe instant coffee manufactured in Ivory Coast. C_1 costs about ₦49.00 per kilogramme while C_3 costs ₦20.00 for the same weight. The moisture content of C_1 is higher than that of C_3. Also the ash and the water-soluble ash of C_1 are higher than those of C_3. C_3 has higher tannin and caffeine content. The high moisture content of C_1 may make it liable to go stale faster on storage than C_3. C_3 however contains more caffeine and so may be more stimulating than C_1.

C_2 and C_5.

C_2 is a Lipton's french coffee made in Nigeria. C_5 is a Mouka's french coffe also made in Nigeria. C_2 costs ₦4.00 per kilogramme while C_5 costs about ₦13.00. C_2 has a higher moisture content, water soluble ash and water extractives than C_5. The ash content for the two samples is about the same. It could then be seen that C_2 is much cheaper than C_5.

C_4 and C_5.

C_4 is a Mouka coffee of turkish blend. C_5 is a Mouka french coffee. Both are made in Nigeria by the same Company. They have the same cost per kilogramme. C_5 has a stronger aroma than C_4. It also has a slightly higher water extractive, water soluble ash and tannin. In view of all these it may be worthwhile buying C_5 instead of C_4.

CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

The result of this work shows that the tea and coffee samples analysed are of similar qualities with other tea and coffee samples analysed and reported in literature with a few exceptions. The few exceptions are in the cases of moisture content, water-soluble ash and caffeine content. Lyons tea, T_1 has a much higher moisture content than the values recorded in literature. The caffeine contents of the tea samples are lower than the values given in literature except for the two imported tea samples Lyons tea, T_1 and CTC Lipton tea, T_2. Hills Bros instant coffee C_1, has a much higher moisture content than given in the literature for coffee samples. Nescafe instant coffee, C_3, Mouka french coffee, C_5 and Mouka turkish blend coffee, C_4 have much lower water soluble ash than given in literature. All the ground roasted coffee samples analysed have lower percent caffeine content than given in literature.

In view of the popularity of tea and coffee beverages, it is advisable that the authority in charge of these beverages in Nigeria should lay down legal requirements for tea and coffee beverages manufactured in the country and those imported into the country from Overseas or other African countries. The legal requirements should include specification for moisture, ash, water-soluble ash, caffeine and inorganic elements.

It should also include requirements for coffee mixtures, that is, the maximum quantity of flavouring or adulterant (for example chicory bits) that should be mixed with pure coffee beans and the proper labelling of the products.

It is suggested that analyses of more tea and coffee beverages be carried out in line with this work to have more data about the different samples flooding the Nigerian markets.

In deciding which tea or coffee is best for consumption the price, water extractives, water soluble ash, tannin and caffeine contents should be considered. It is found in this work that a high price does not necessarily mean that the product is better than the other products around, and that it gives more for its money. Sometimes the high price may be due to the import duty for the imported samples.

In this work it is found that tea has a higher caffeine content than ground roasted coffee, and instant coffee contains more caffeine than either tea or coffee. However, sampled opinions showed that nervousness is felt only when coffee is taken, and it does not usually occur with the intake of tea. It is therefore being suggested that an examination of the differences between coffee and tea, and between their organic constituents might produce useful informations. This will help isolate other biologically active substances in coffee.

The relationship of caffeine intake to various diseases including heart disease, development of cancer, pathogenesis of peptic ulcer, hepatitis and cirrhosis of the liver as are being speculated (Graham, 1978) should be further inve stigated. Indeed, the chronic effects of caffeine is controversial and of much interest. While some workers see nothing dangerous in the few cups taken per day others see it as a health hazard. They however agree that the human fatal dose is 10g or 170mg per kilogram of body weight (Select Committee on GRAS substances, 1976 and Timson 1978).

Also, in view of the therapeutic importance and the toxicity of tannin it is necessary to have an official lethal dose to man. Moreso when it is present in such popular drinks as tea and coffee.

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