

Recognition and Evaluation of Authenticity of Tea and Coffee

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Abstract: “Adulteration” or “Deterioration” of different food articles is the process which disparages the standard index of food by purposeful addition of subordinate quality of materials or by eradication of valuable ingredients that unluckily affect the health of the end user. Food deceive has always been one of the major concerns since pre-historic times. Tea and Coffee are the pre-eminent beverages all over the world. Both the liquid refreshments are established as stimulant beverages that are affluent in caffeine, sugars, lipids, aromatic substances etc. and manifest a wide variation in quality when taken from different producers i.e.; can be inferior or superior in grade depending upon the type of adulteration present in them. Bastardized tea and coffee contain chemicals, additives and many more substances which provide divergent flavours to the beverages (tea and coffee). This paper provides contemplation about the presence of adulterants in tea and coffee samples whose evaluation was done on the basis of laboratory tests. The procured results showed that which type of contaminants can be present or mixed in any tea or coffee. The study also provides a brief idea about the pH of tea samples (which can change taste accordingly) and also the quantity of caffeine in both the beverages. A nearer approach also showed that “tea contained four times lesser caffeine content than coffee”. Overall, this paper will enlighten about the types of adulteration present in various tea and coffee samples and also the effects of them on human health.

Keywords: Adulterants, Beverages, Adulteration, Lipids

I. INTRODUCTION

Food is basically the fundamental structural unit consisting of all the properties about which the human life circulates. A variety of food is present on our globe and thus it is classified into various types out of which tea and coffee are classified under beverages. So, food being elementary unit for our survival brings the concern of determining the quality of stuff we are having whole of the day as it can affect our health in a major way. Food delude has always been one of the major concerns since ancient times. Adulteration is the act of mixing of an underling i.e.; low quality and even harmful materials that causes changes in the original material, decreases its quality and harms human health^{1,2}.

Tea and Coffee are the foremost preferred beverages all over the globe². Tea, coffee are established in our system as stimulant beverages which are rich in caffeine, polysaccharides, amino acids etc. Both the beverages show a great variation in qualities when taken from different producers as they are grown under different environmental conditions of soil, rainfall, altitude, methods of processing especially fermentation, roasting of them, but the extensive factor is the presence or absence of adulterants. All these factors ultimately influence the standard parameters which bring a variation in the market value of the products. As a result, higher grown products are highly priced and exhibit superior properties. In past years, the matter of adulteration of these items have received an outsized attention of food analysts but as we all know adultrators always find a brand new way of misleading people and thus new challenges are always present. So, there is an excellent need of sharpening the tools of analysts to cope up with these challenges.

A) Tea

Tea essentially contains 2 to 3 leaves and also the terminal bud of the plant *camellia sinensisvar.sinensis*, *sinensisvar.assamica* and allied species belonging to the genus *camellia*. Crosses between these and also the other species like *camellia taliensis* and *C-irrawadiensis* accounts for many of the tea under cultivation. The species *camellia sinensisvar.sinensis* is employed in puer and indian teas and species *camellia sinensisvar.assamica* is employed by Chinese, Japanese and Formosan teas. The picking of leaves are done at various stages of their growth out of which earlier picked ones are considered best.

a) Adulteration of Tea

The adulterants present in tea are exhausted tea leaves, leaves of other species like dried bilberry leaves, hawthorn and beech leaves. Tea is also adulterated by colouring substances that increases the astringence such as catch, borax and sodium carbonate and non-tender stalks and leaves are also used as adulterants. The lower %age of extractive and tannins show exhausted tea. Other adulterants of tea are iron, coal tar, leather flakes, sand. Catechu is also used as adulterant in tea, fabric dyes, husk of pulses, chicory and cereal starch all are non-permitted materials and used as adulterants as tea³. The amount of caffeine in tea sample is also detected as we know that only 400mg per day of caffeine is good for human body. Thus, by some physical, chemical, spectroscopic and colorimetric tests we can easily detect the adulterants.

B) Coffee

Coffee is basically classed in two types of beans Arabica and Robusta beans. Arabica beans tends to have sweeter, softer taste with tones of sugar, fruit and berries on the other hand Robusta however, has a stronger, harsher taste with grain like overtone and peanuty after taste. As a result, Arabica demands higher prices in market. So, it is important to identify and quantify the coffee products. These both can be easily, physically distinguished but by chemical analysis it was seen that unroasted Arabica coffee contain higher concentration of sucrose, glucose and fructose. Free amino acids presence is high in unroasted Robusta as compared to Arabica. Similar results were obtained for alkaline and heterocyclic amino acids for both type of beans. However, both are degraded during roasting via *Strecker Degradation* to various flavour compounds like pyrroles, pyridines, furans etc.

b) Coffee Substitutes and Adulterants

The substitutes are provided to improve the health risks. Coffee companies are nowadays using chicory powder as a substitute to reduce the caffeine content so that health factors can be counted on. As only 400mg of caffeine per day is considered good for human health, substitutes are needed to reduce the caffeine content. But more amount of chicory and cereals are also not good. Other adulterants like clay, iron fillings, powdered date or tamarind seeds are also added to reduce the market prices. The percentage of caffeine is also detected and other adulterants are detected by chemical tests easily⁴.

C) Impact of food Adulteration on Health

The substances that help to falsify food quality are hazardous to health. According to Henson and trail (1993) define food safety as “the inverse of food risk-the probability of not suffering from a hazard by consuming a specific food”. Food borne disease (FBD) causes a huge public health impact, as well as corresponding economic and social consequences. As per a report FBD causes approximately 76 million of illness per year in U.S.A and about 2,366,000 cases in England and wales (Mead et al 1999, CDC 2003).

a) Special Case of Tea

The use of pre-used tea leaves and processed and coloured tea causes liver disorders and the presence of high caffeine content can cause faster heart beats. It may also lead to alteration of heartbeat rhythm i.e. atrial fibrillation reported generally in youngsters. The presence of iron fillings can affect the blood flow and can cause harm.

b) Case of Coffee Powder

The presence of adulterants like tamarind seeds, date seed powder, caffeine content, chicory powder etc. Can cause diarrhea, stomach disorder, giddiness and joint pains. Thus, adulteration elimination becomes necessary.

II. METHODOLOGY

A) Required Chemicals and Reagents

1. Concentrated Hydrochloric Acid
2. 2.10% Aqueous Lead Acetate Solution
3. Silver Nitrate Solution
4. Potassium Manganate (KMnO_4) Solution
5. 1% Aqueous Iodine Solution
6. Ethanol
7. Potassium Ferrocyanide Solution
8. Chloroform
9. Potassium Hydroxide Solution
10. Distilled Water, Samples of tea and coffee
11. Slacked Lime [$\text{Ca}(\text{OH})_2$]

B) Methods to Detect Adulteration in Tea

1. **Detection of Iron Fillings:** Take the tea sample in a glass plate and held the magnet all over the surface of the plate. Presence of Iron makes tea sample get attracted towards the sample.
2. **Detection of Coal Tar Dye:** Take a small amount of the tea sample in a test tube and add 5 ml of conc. HCl to the test tube. Appearance pink or crimson colour just after addition of acid shows the presence of coal tar dye in the tea sample.
3. **Detection of Artificial Colour:** The tea was spread on the surface of a clean beaker containing water. If colour of water changes then the tea is adulterated and it was dyed by artificial colours.
4. **Detection of Catechu:** Take small amount of the sample in a test tube and then add 5 ml of water and then add few drops of 10% aqueous lead acetate solution and then filter solution. Now, to the filtrate add few drops of silver nitrate solution, if grayish cloudiness appears then catechu is present in the tea.
5. **Test for presence of Sand:** In a test tube take tea sample and then add 7ml of water to it and then mix it well. If sedimentation is seen then sand is present, otherwise not.
6. **Test for Cereal Starch Detection:** Take the tea sample in a test tube and then add a little amount of distilled water to it and then on heating the solution we get a coloured solution. Now to the coloured solution add (1:1) KMnO_4 solution and dilute HCl which decolourises the solution and then if on addition of 1% aqueous Iodine solution gives blue coloured solution then cereal starch is added to the tea sample.
7. **Test for Azo Colours Detection:** Take the tea sample in a test tube and then add few drops of strong alcohol to it and then evaporate it till dryness and then add water to it. If on addition of water colour changes to red/yellow/orange then the tea is adulterated by azo colours.
8. **Test for Detection of Chicory:** Take the sample in a test tube and add 2 drops of concentrated HCl to it. Boil the obtained solution and then add about 15 drops of Potassium ferrocyanide solution to the test tube and obtained solution is boiled till dark green colour is seen. Now, if brown and murky colour is seen then chicory is present and if the ppt settles down at bottom leaving a supernatant solution of light yellow colour then it is absent in the sample.
9. **Test for determination of Caffeine:** Take 10gm of the powdered tea sample in a 500ml beaker and then add 150ml of distilled water to it and then introduce it to the flame and let it boil for about 30 minutes. Filter the solution obtained and then to the filtrate add 10% aqueous solution of lead acetate with continuous stirring until no ppt is seen and then filter the solution again in another beaker. Now, boil the obtained filtrate till the

solution becomes about 25ml. After this remove it from flame and the cool it and as the temperature becomes 25°C add chloroform to it with continuous stirring (about 25ml) and then put the solution into a distillation flask and separate both the layers, remove the chloroform into a separate beaker and to the aqueous layer again add 20ml chloroform and repeat the same process until the present solution gets solidified. Collect the substance in a pre-weighted crucible and then weigh it using analytical balance.

$$[\% \text{ OF Caffeine} = \frac{\% \text{ wt. of substance obtained}}{\text{wt. of substance taken}} \times 100]$$

- 10. Procedure for Analysis of Bulk Density:** Bulk density is defined as ratio of mass of powdered substance to its bulk volume (take sample in a graduated measuring cylinder and tap it manually till constant volume is obtained and note the change)

$$[\text{Bulk density} = \frac{\text{mass of powder}}{\text{bulk volume}}]$$

- 11. Determination of Acidity:** Take 2gm of tea sample in a beaker and add 20ml of distilled water to it and heat it till boiling and then cover the beaker and rest it to cool at room temperature and then filter the solution and test it by using PH stripes (acidic).
- 12. Detection of Exhausted Tea Leaves in Sample:** Take a glass plate and spread little slaked lime $[\text{Ca}(\text{OH})_2]$ on it, now sprinkle tea dust on the slaked lime. Orange, red or other shades of colour spreading on lime will show adulteration. Pure tea will normally show greenish yellow colour due to presence of chlorophyll and it appears after sometime.

C) Tests for Detection of Adulterants in Coffee Powder

- 1. Detection of Clay and tamarind seeds in Coffee Powder:** Take a transparent glass of water and add a teaspoon of coffee powder to it and stir it for five minutes. If coffee powder is pure then it will float over water and if it is impure then it will show colour and not float completely, clay will settle down at bottom showing the presence of adulterants.
- 2. Detection of Chicory Powder in Coffee:**
 - a. Physical Test:** take a beaker containing water and then add coffee powder to it. Just after the addition of coffee powder the powder containing chicory in it will start to sink towards bottom.
 - b. Chemical Test:** to the coffee powder (10gm) add 250 ml of water and mix it well. Now to the above solution add excess of basic lead acetate solution, a ppt will be seen. Allow the ppt to settle down at bottom. If liquid obtained is coloured then chicory powder is present in coffee.
- 3. Test for Detection of Iron Fillings in Coffee:** take the coffee sample in glass plate and hold the magnet near the glass plate. Presence of iron in coffee will make it get attracted towards the magnet.
- 4. Detection of Powdered Date Seeds or Tamarind Powder in Coffee:** Sprinkle a little coffee powder on a piece of bloating paper and spread a few drops of KOH solution on the paper. If brown colour around the coffee powder is seen then it is adulterated.
- 5. Test for determination of Caffeine:** Uses same method as mentioned in detection of caffeine for tea.

$$[\% \text{ OF Caffeine} = \frac{\% \text{ wt. of substance obtained}}{\text{wt. of substance taken}} \times 100]$$

III. RESULTS AND DISCUSSION

A) Discussion of Results of Tea Samples

- 1. Detection of Iron Fillings:** The results of physical analysis showed that all the samples taken for testing showed absence of iron particles in them. Generally, iron fillings are added in tea to increase the weight of the product which makes it easy for the retailer to earn more profits. Sometimes this happens unintentionally too. The presence of very old machinery systems in our country sometimes leads to the mixing of iron particles, during manufacturing process, improper packaging leads to addition of iron particles during transport.

2. **Detection of Coal Tar Dye:** The chemical analysis showed that out of taken 5 samples, 1 sample of tea contains coal tar dye in it. The brown-black liquid generated during the incomplete burning of fuel is coal tar. It is highly viscous. Containing numerous carcinogens coal tar is a complex chemical mixture, which belongs to polycyclic aromatic hydrocarbon (PAH) class and the PAHs are reasonably expected to cause cancer. The manufacturers add coal tar dye to tea as it gives a dark colour to tea which causes good appearance and easily attracts the consumers.
3. **Detection of Artificial Colour:** Chemical analysis of tea samples showed that the samples A, C, E were adulterated by the addition of artificial water soluble colours, whereas rest of the samples showed absence of them as tabulated below. The tea leaves are dyed due to various reasons including selling low quality of tea in good prices, to attract customers etc.
4. **Detection of Catechu:** It was observed that out of all five samples taken, 3 samples were adulterated by presence of catechu. Catechu is an extract acacia of trees used variously as a food additive, dye. Catechu has no odour, with constricting and bitter taste, followed by a little sense of sweetness. Catechu is often mixed with tea to make it more engaging and attractive.
5. **Presence of Sand and Cereal Starch:** The chemical tests showed that no sample contains sand or cereal starch in it as adulterating materials. Sand and cereal starches can be intentionally added to tea to extend the weight of the whole product. Sometimes, it could even be added unintentionally while processing, packaging, transportation.
6. **Detection of Azo Colours:** The sample A, C, E showed presence of dyestuff on chemical detection as shown in the table below. Azo dyes are synthetic colours which have azo group as a part of their structure and are more stable than most of the natural food dyes. Adulteration with azo dye provides a robust flavour and colour. Thus, tea is adulterated with these dyes to draw in customers.
7. **Identification of Chicory:** From the applied tests it was observed that three samples were adulterated with chicory. One of the common adulterants of tea is prepared from the foundation of herb of chicory plant, *Cichoriumintybus*. The root of Chicory plant gives a pleasant aroma when it's added to tea. It also acts sort of a sedative on the central nervous system and it can delay the traditional reaction time in some individuals.
8. **Detection of %age of Caffeine:** As per the results obtained from the conducted experiments, sample C contained highest percentage of caffeine content and Samples A and E contained lowest. High dosages of caffeine can lead to anxiety, heart problems, sweating etc.
9. **Analysis of Bulk Density:** The results showed that the sample B showed highest value of bulk density and sample D showed lowest i.e. the space occupied for air is more than that for the particles.
10. **Determination of Acidity:** The results obtained from the tests showed that the sample B has the highest value of PH (acidic) and the sample A has lowest value (very acidic) as mentioned within the table. With regard to the taste of the products, the results show relationship between the pH and the taste.
11. **Detection of Exhausted Tea Leaves:** The estimation of samples showed that 80% of the tea leaves were adulterated by using pre-used tea leaves. This can be done to decrease the value of production and also to sell a budget quality of tea.

B) Discussion of Results of Coffee Samples

1. **Detection of Clay and Tamarind Seeds in Coffee Powder:** All the samples tested negative for clay. The presence of clay in coffee powder is very harmful since it can result in diarrhea and T.S. stomach disorders, giddiness. Clay are often added to increase the weight of product.
2. **Detection of Chicory Powder in Coffee:** Two types of tests i.e. physical and chemical were performed to detect the presence of chicory in coffee powder. It was seen that out of 4 samples 3 were tested positive for chicory. Chicory (*cichoriumintybus*), is a blue – flowered plant belonging to the family of Asteraceace. The roasted chicory root (which is actually added to coffee) contain no caffeine and it also adds up its own flavor to coffee. It looks similar to coffee and thus coffee can be adulterated easily using it and it reduce the bitter flavor of over-roasted low-grade coffee beans.

3. **Test for Detection of Iron Fillings:** Results obtained on the basis of performed test showed that all taken samples showed absence of iron particles in them, iron particles are added generally to increase the weight of product and earn more profits.
4. **Test for Detection of Powdered Date or Tamarind Seeds:** All samples taken for examination contained date seeds in them. The date seeds or tamarind seeds are added in coffee powder as they show good colour of the product which attract the costumers.
5. **Identification of Total Caffeine Content per gm of Coffee:** The obtained results showed that the sample 4 contained highest %age of caffeine and sample 3 contained lowest, whereas others lied in between them. As per a test conducted a person should have not more than 400 mg per day of caffeine as high caffeine content affects the brain and it causes problems like anxiety, sweating etc.

C) Presence of Total Adulterants in Tea Samples

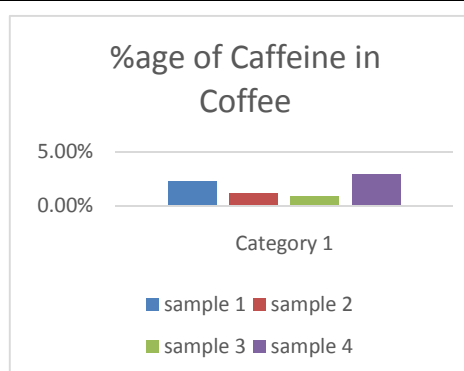
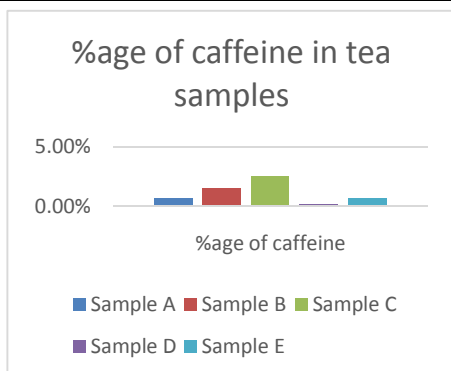
Following adulterants were found in the tea samples:

Adulterants	Sample A	Sample B	Sample C	Sample D	Sample E
<i>Iron Fillings</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>
<i>Coal Tar</i>	<i>Present</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>
<i>Artificial Colour</i>	<i>Present</i>	<i>Absent</i>	<i>Present</i>	<i>Absent</i>	<i>Present</i>
<i>Catechu</i>	<i>Present</i>	<i>Present</i>	<i>Present</i>	<i>Absent</i>	<i>Absent</i>
<i>Sand</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>
<i>Cereal Starch</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>
<i>Azo Colours</i>	<i>Present</i>	<i>Absent</i>	<i>Present</i>	<i>Absent</i>	<i>Present</i>
<i>Chicory</i>	<i>Present</i>	<i>Present</i>	<i>Absent</i>	<i>Absent</i>	<i>Present</i>
<i>Caffeine</i>	0.6%	1.5%	2.5%	0.12%	0.6%
<i>Bulk Density</i>	1.1	1.15	0.85	0.8	0.95
<i>PH Value</i>	1	6	5	3	5

D) Presence of Total Adulterants in Coffee Samples

Following adulterants were present in the tested coffee samples:

Adulterants	Sample 1	Sample 2	Sample 3	Sample 4
<i>Clay</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>
<i>Chicory Powder</i>	<i>Absent</i>	<i>Present</i>	<i>Present</i>	<i>Present</i>
<i>Powdered Date Seeds</i>	<i>Present</i>	<i>Present</i>	<i>Present</i>	<i>Present</i>
<i>Iron fillings</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>	<i>Absent</i>
<i>Caffeine</i>	2.25%	1.18%	0.88%	2.88%



Thus, from the obtained results it is observed that almost all the tea and coffee samples were adulterated by using common adulterants i.e. sand, chicory, artificial colour, catechu, cereal starch, clay, powdered date seeds respectively. It was also observed that tea contained less amount of caffeine in comparison to coffee.

IV. CONCLUSION

Adulteration is the process which disparages the quality value of food by intentional addition of inferior quality of material or by extraction of valuable ingredients that unluckily affect the health of consumers.

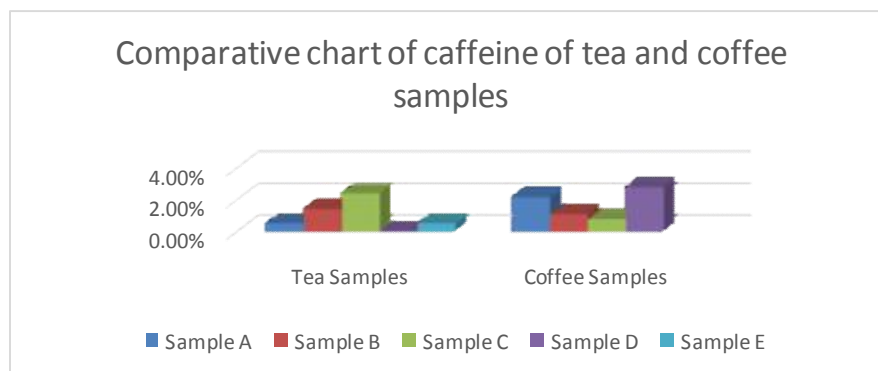
To sum up following are the contemplations of the study. The evil of adulteration has its roots embedded deep down in prehistory, where it was a synonym for deception. The previous studies/researches have shown that the beverages common to us i.e. tea and coffee are adulterated by many kinds of adulterants like sand, iron fillings, chicory, coal tar dye, clay etc. the results obtained from the chemical tests of samples of tea and coffee showed that these were mainly adulterated with clay, chicory, artificial colour, coal tar, azo dyes, exhausted tea leaves, date and tamarind seeds powder.

It was seen that out of all the tea samples taken for analysis, samples which were higher in prices showed presence of lesser amount of adulterants in comparison to that of the cheaper ones. Since, the manufactures try to make products more appealing to the consumers by adding adulterants like artificial colours to inferior quality tea which makes it look good. The dyed tea leaves (using artificial colours) increases more profits as they can be sold at higher prices



Analysis of different coffee samples showed that all the samples were adulterated with powdered date seeds which make coffee look darker and richer in colour and can be sold at good prices. Similarly, 80% of the samples were adulterated by chicory powder. Since, chicory is not a coffee bean so, it tastes different and has its own aroma. But some studies also considered that chicory powder can be added in coffee to reduce the higher content of caffeine as it's not good for health.

It was also seen that tea sample contained comparatively less caffeine than coffee samples. So, it also follows the saying of previous studies that "one cup of coffee is equivalent to four cups of tea".



In spite of the fact that the studied samples are adulterated, it is not simply possible to prevent and eliminate adulteration even after observing the samples. Most of the consumers didn't have knowledge about food adulteration and its health consequences that is it can lead to a serious health injury. Tea and coffee are the most preferred drinks in India but due to more poverty in the developing countries like India the manufacturers mix adulterants to the inferior quality products and make them look like the higher priced products so that trust of consumers can be won and more and more can buy the product. And due to limited knowledge about adulteration and lesser resources people buy these products. Furthermore, it was also observed that those who were able to detect adulteration were not enthusiastic enough to create awareness and prevent adulteration of food and were also not interested to report in consumers court. Hence, it is very necessary to generate awareness about the adulteration of tea and coffee and also the importance of its elimination and prevention among the population. Regular analysis of different tea and coffee samples will also help in generating awareness about the beverages adulteration. Just by putting some efforts we can eliminate this problem and can have best quality of food stuff.

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