IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

EXTRACTION OF CAFFEINE FROM COFFEE AND EFFECT OF COFFEE ON GOAT STOMACH

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Abstract: Coffee is one of the most abundantly consumed beverages across the world. Caffeine present in coffee is a natural simulant and gets the drinker quickly to hook on to it. Coffee has many healthy as well as harmful properties. This paper aims to highlight the effect of coffee and caffeine on stomach. To understand the effect of coffee on human stomach, an experiment was devised using goat stomach skin to simulate the environment inside human stomach.

Index Terms **– Coffee, Caffeine, Caffeine Extraction, Liquid-liquid Extraction, Effect of Caffeine on human body.**

I. INTRODUCTION

Coffee is one of the most abundantly consumed beverages all over the world. Regular coffee-drinkers can barely function without the drink in their system. Coffee has been known to increase alertness, improve concentration and reduce fatigue. [1]

India, even though primarily a tea-drinking country, has enthusiastically taken on the trend of coffee drinking, especially in the urban areas. The European style cafe chains that offers various types of coffee along with being hang-out spots for the young population immediately piqued their interest and this further increased the coffee drinking population of the country. Regions in south of India especially have quite a high percentage of regular coffee drinkers since many generations.

In the past ten years, per capita consumption of coffee in India has increased 40%. India is also the sixth largest producer of coffee in the world. However, almost 80% of its produce is exported.[2] But with the increasing consumer base for coffee in the country, more and more efforts to improve the local coffee market is being made to increase not only the quantity of coffee but also to improve the quality of the beans.

This increase in consumer market also saw an increase in the interest showed by public and scientific community towards coffee. The effect of the beverage on health and its negative and positive roles were widely studied upon by researchers and like most of the things, this beloved drink was also found to have its own quota of consequences, good and bad.

Coffee contains caffeine which is a natural stimulant. It has a multitude of effects on various parts and systems of the human body and is what is responsible for the addictive properties of coffee. [1]

II. LITERATURE REVIEW

2.1 Coffee

The known evidence of coffee, knowledge and usage, dates back to the 15th century. Ehiopian and Yemen cultures have cited the use of coffee in the 14th and 15th centuries. [3] The beans obtained from the coffee shrub were used by the people to brew a concoction that energized them and helped them improve their concentration. The drink later reached Europe in the 17th century travelling through Cairo, the Middle East and Constantinople, where it became an instant hit among the people for its exquisite taste and aroma.[4]

Coffee comes from plants belonging to the genus Coffea. The two commercially important species are Arabica and Robusta out of the nearly 100 species that are estimated to exist. The optimum conditions required for these trees grow best include rich soil, mild temperatures, frequent rain and shaded sun.[5] The coffee beans go through a series of steps between when they are planted and brewed to make a cup of coffee. These steps typically involve planting the shrubs, harvesting the cherries, processing them, drying the beans, milling them, roasting the coffee beans, grinding them and finally brewing the coffee. [6]

The caffeine in coffee has a lot of benefits when consumed by healthy adults within the daily-intake limit prescribed, which is generally about 400 mg, though it varies from person-to-person. The benefits include boosting metabolic rate, improving physical performance, providing essential nutrients like Riboflavin, Manganese, Magnesium, Potassium, Niacin, etc. Coffee has also been seen to reduce the risk of type II diabetes, Alzheimer's disease, Parkinson's disease and dementia among drinkers. Coffee also has a lot of antioxidants, thus reducing the risk of cancer. [7] The caffeine content in coffee depends upon the specific type of bean being used.

2.2 Caffeine

Caffeine is an alkaloid (1,3,7-trimethylxanthine) and occurs naturally in tea leaves and coffee beans. Cocoa beans, from which chocolates are made, also contain a caffeine-like compound. It is the world's most consumed psychoactive drug.

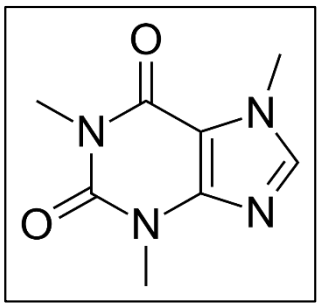

Fig -1: 2-D Structure of Caffeine

It is also artificially added to many types of sodas and energy drinks. This is because of how caffeine stimulates the Central Nervous System and keeps people alert and prevents tiredness. When consumed, 99% caffeine is absorbed into the bloodstream. It is lipophilic and crosses all biological barriers and is supplied to all body tissues. It also crosses the blood-brain barrier and the placenta.[8]

It has been speculated that caffeine causes risk of heart diseases among its takers but there is no conclusive evidence of this. However, animal studies have indicated that it might be a weak teratogen (an agent that causes birth defects in an embryo or fetus), so pregnant women are advised to limit their intake of caffeinated beverages. [9]

2.3 Effects of Caffeine on Body

Caffeine is probably the most frequently ingested pharmacologically active substance in the world. When consumed at regular intervals, the body develops tolerance for caffeine and this depends upon the amount of consumed by individuals. Once accustomed to a particular amount, a cut down in the intake leads to caffeine withdrawal syndrome. The symptoms include headache, nausea, anxiety, restlessness and the intense urge to drink coffee. [8]

It interacts with various systems of the body and has the following results:

Central Nervous System:

•There is increase in vigilance and arousal when coffee is consumed.

•Ingesting caffeine before sleep has shown increase in sleep latency, reduction in total sleeping time and an overall poorer quality of sleep.

Cardiovascular Effects:

•In hyper-tension prone drinkers, acute intake of caffeine has shown an increase in blood pressure. However, long term consumption has shown the development of tolerance and thus, no effect on blood pressure in the longer run.

Respiratory Effects:

•A primary increase in the respiratory rate can be observed and this is directly proportional to the plasma-caffeine level.

•In patients with asthma, caffeine acts as a bronchodilator.

III. MATERIALS AND METHODS

3.1 Extraction of Caffeine

Caffeine was extracted from coffee by employing solvent-extraction procedure.

3.1.1 Materials used:

i. Sample: Coffee powder from various brands namely Nescafe, Bru, Fresh N Pure, Continental and House Coffee were used - 15 gm each

ii. Reagents:

a) Sodium Carbonate (Na_2CO_3) - 3 gm
b) Dichloromethane (DCM) - 40ml

iii. Apparatus:

a) Separating Funnel
b) Beaker
c) Petri dish

iv. Miscellaneous:

a) Distilled water (DW) - 100 ml
b) Tea strainer
c) Boiling Water Bath

3.1.2 Methodology:

Fig -2: 15 gm coffee powder from each of the 5 selected brands was weighed in a beaker.

Fig -3: 2 gm Na_2CO_3 and 100 ml DW were added to it.

Fig -4: The mixture was boiled for 10 minutes on a water bath and filtered using a tea strainer. The filtrate was collected and cooled.

Fig -5: Upon cooling, it was transferred into a separating funnel. 10 ml DCM was slowly poured into the funnel and the 2 layers were mixed by gently stirring them for about 5 minutes.

Fig -6: The separating funnel was then kept undisturbed for 5 minutes to allow separation to occur. Upon separation, two distinct layers were seen. The organic phase; i.e.; the clear layer on the bottom was collected.
The process was repeated thrice with fresh DCM so as to completely extract all of the caffeine.

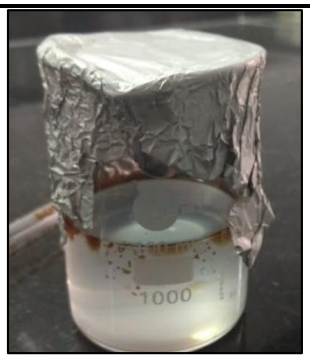

Fig -7: The collected content was transferred into a beaker and covered with aluminum foil before it was transferred onto pre- weighed petri plates to evaporate the excess DCM and obtain caffeine crystals.

3.2 Confirmatory Test for Caffeine

The confirmatory test for detecting the presence of caffeine in a mixture involves testing the presence of alkaloid. Caffeine being an alkaloid, if present, will show positive results for the test.
Dragendorff's reagent is used to detect alkaloids in a sample. It is a colour reagent and reacts with the alkaloids in the sample to produce an orange or orange-red precipitate.

If caffeine has successfully been extracted from the coffee powders, then orange or orange-red precipitate has to be formed in this confirmatory test.

3.2.1 Materials used:

i. Sample: Caffeine extracted from all coffee 5 samples- 1 ml each
ii. Reagents: Dragendorff's reagent
iii. Apparatus: Test tubes – 10
iv. Miscellaneous:
   a) Distilled water (DW) – 10 ml
   b) Pipettes

3.2.2 Methodology:

i. For each sample, two test tubes were taken. One was named 'test' and the other 'control'.
ii. 0.5ml caffeine solution was added to both of the test tubes.
iii. In the tube labelled 'control', 3-4 drops of DW was added.
iv. In the other tube labelled 'test', 3-4 drops of Dragendorff's reagent was added.

3.3 Effect of Coffee on Goat Stomach Skin

To understand the effect of coffee on human stomach, an experiment was devised using goat stomach skin to simulate the environment inside of human stomach.

3.3.1 Materials used:

i. Goat stomach skin – 5 gm
ii. Hydrochloric acid (HCl) – 6 ml
iii. A mixture of coffee powder and water
iv. Extracted caffeine
v. Petri plates, pipettes, etc.

3.3.2 Methodology:

i. The goat stomach skin was cut into approximately equal sized rectangular pieces.
ii. These pieces were placed onto 3 clean and dry petri plates.
iii. 2 ml HCl was added into each of the plates.
iv. The first plate was labelled 'control'. In the second plate, 2 ml of the coffee and water mixture was added and in the third plate, the extracted crystals was added.
v. All the three plates were incubated for 20 minutes and then observed.

IV. RESULTS AND DISCUSSIONS

4.1 Extraction of Caffeine

Crystals were obtained once the DCM on the plates had evaporated. These crystals were tested to confirm that they were indeed caffeine crystals using Dragendorff's reagent.

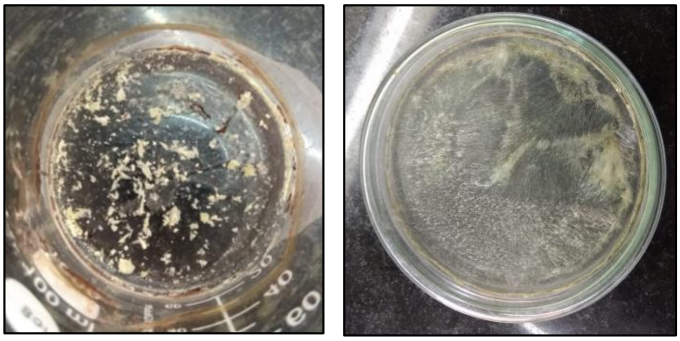

Fig -8: Crystals obtained after extraction.

4.2 Confirmatory Test for Caffeine

- Adding Dragendorff's reagent to the extracted sample clearly showed reddish-orange colour in the tube labelled 'test', confirming the presence of the caffeine. Thus, caffeine was successfully extracted from all of the coffee samples.

Fig -9: Confirmatory test for caffeine
Left tube: 'Control' tube (yellow colour)
Right tube: 'Test' tube (orangish-red colour)

- The pre-weighed plates containing the caffeine crystals were weighed once again and the difference in the weights were noted down to be the weight of caffeine obtained from each coffee sample. The obtained quantities are as follows:

Sr. No.	Brands	Weight of caffeine obtained
1.	FRESH N PURE	360 mg
2.	HOUSE COFFEE	400 mg
3.	CONTINENTAL	330 mg
4.	NESCAFE CLASSIC	480 mg
5.	BRU	390 mg

Table- 1: Caffeine content extracted from coffee.

- From the quantities, it was seen that, Nescafe Classic had the most amount of caffeine, i.e. 480 mg from 15 gm coffee and that Continental had the least amount, 330 mg from 15 gm coffee.

4.3 Effect of Coffee on Goat Stomach Skin

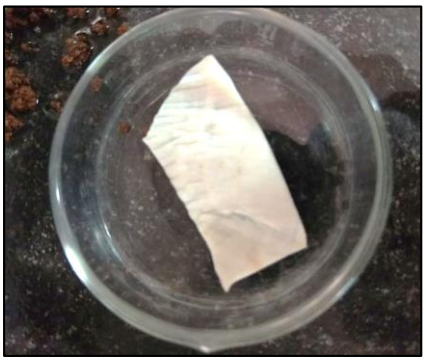

Fig -10: In the first petri plate (goat stomach + HCL), no changes were seen after 20 minutes of incubation.

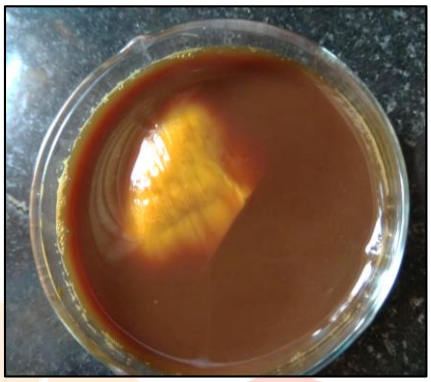

Fig -11: In the second petri plate (goat stomach + HCl + coffee), it was seen that color of the skin became reddish orange. Skin rashes were also observed and skin became swirled after 20 minutes of incubation.

Fig -12: In the third petri plate (goat stomach+ HCl + caffeine), the color of the skin changed to golden. The thickness of the skin was also observed to decrease a little after 20 minutes.

- Thus, it can be inferred that the caffeine in coffee affects the lining of stomach.
- This happens because coffee and its caffeine content increases the acidity of stomach leading to the degradation of the gastric lining. [10][11]

V. CONCLUSION

Caffeine is a natural stimulant found in coffee, tea, chocolate, and other food and drinks. Caffeine is defined as a drug because it stimulates the central nervous system. It affects kids and adults similarly and, at lower levels, can make people feel more alert and energetic. Foods and drinks with caffeine are everywhere, but it's wise to keep caffeine consumption to a minimum, especially in younger kids.

From the result of the performed experiment, it can be concluded that coffee and caffeine leads to an increase in the natural acidity if the stomach. This is because caffeine has a direct effect on the gastric acid and pepsin secretion. This, in the long run, can lead to peptic ulcers in regular drinkers. [8] This effect is predominant when coffee is ingested into an empty stomach and leads to acute heartburn.

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