1, 3, 7 TRIMETHYLPURINE-2, 6 DIONE (CAFFEINE) EXTRACTION FROM TEA

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Abstract : 1, 3, 7-Trimethylpurine-2, 6-dione (Caffeine) is a member of the class of compounds Organic chemists call alkaloids. Alkaloids are basic compounds which contains nitrogen. Caffeine is usually bitter in taste. Caffeine is physiologically active in human bodies and has mild stimulating effects to the central nervous system of human body. This study is focuses on the use of multiple extraction technique to isolate, purify and characterize the alkaloid caffeine from tea. Here is a comparison between many processes for extraction of caffeine from tea or coffee and finalized the polar-non polar solvent extraction. This study is helpful to determine an easily operable, more durable and cost effective technique to extract caffeine from tea. Selection of process/solvent must be done according to the process which gives highest % yield and which is more suitable for further processes.

IndexTerms **- caffeine extraction, tea, polar-non polar solvent extraction.**

I. INTRODUCTION

1, 3, 7-Trimethylpurine-2, 6-dione (Caffeine) is a basic compound which acts as a stimulant. It contains nitrogen compound and is alkaloid. Most of us are addicted to caffeine. Caffeine is a stimulant which targets the central nervous system of human body. Caffeine is the most consumed psychoactive drug. It found in most of the seeds, nuts and leaves of the plants. Caffeine can be extracted from tea, coffee and cocoa. Caffeine is having both positive and negative health effects on normal basis. It can be boon if it is consumed in a proper and appropriate manner or quantity. But if over intake of caffeine can be done, it will be harmful for health. Caffeine extraction can be done mostly by coffee as it is having the most content of caffeine in it. But here, this is a study of extraction of caffeine from tea to make a process easy, durable and cost effective. There are several methods to extract the caffeine from tea. We are going to study the comparison of two processes which can be useful to understand the importance of each process and will helpful to decide the more durable, easily operable and cost effective method which gives highest amount of yield. This study is focuses on the process polar-non polar solvent extraction in which dichloromethane can be used as a non-polar solvent.

There are several process for extraction of caffeine from tea/coffee are listed below:

II. Swiss water process
III. Organic solvent (Direct method) extraction
IV. Organic solvent (Indirect method) extraction
V. Supercritical carbon dioxide extraction
VI. Polar-non polar solvent extraction

1.1 OBJECTIVE

- The main objective of this study is to find out the process/solvent which gives maximum % yield and the process must be easy to operate, durable and less costly.
- Comparison between several processes can be done to understand what kind of process or solvent can be included in the existing process. Comparison can also be done between the polar-non polar solvent extraction and supercritical carbon dioxide extraction.
- Selection of the solvent/process is also an important task in this study.

1.2 PREVAILING PROCESS

- Supercritical carbon dioxide extraction
- Raw material: Green coffee
- Process is difficult to operate on a small scale
- Big CO_2 storage tanks required

- Process is quite expensive

1.3 COMPARISON BETWEEN TWO PROCESSES

POLAR-NON POLAR SOLVENT EXTRACTION	SUPERCRITICAL CARBON DIOXIDE EXTRACTION
Easy to operate	Difficult to operate
Less costly	More costly
Can be operated on lab scale	Cannot be operated on lab scale
Less set-up required	Industrial set up required
No storage required	CO_2 storage is difficult
Less time required	Time consuming

2. PROCESS DESCRIPTION

As we have selected polar-non polar solvent extraction method, we must know about the polar and non-polar quantities in the process. Here, water acts as a polar quantity and dichloromethane will be used as a non-polar solvent.
Here is the flow diagram and stepwise procedure with experimental data.

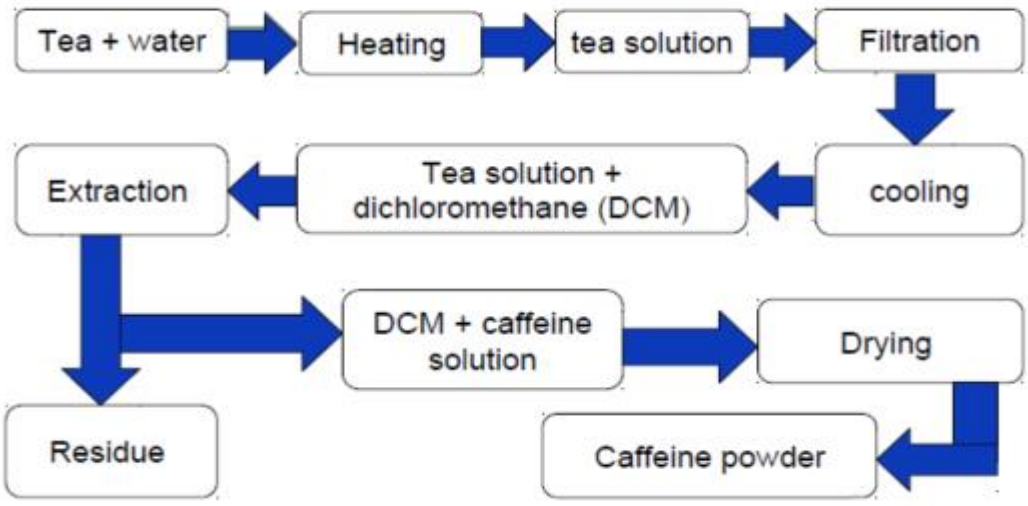
2.1 REAGENTS REQUIRED

- Dichloromethane
- Distilled water
- Tea powder

2.2 MATERIALS REQUIRED

- Beaker
- Hot plate
- Water bath
- Separating funnel

2.3 FLOW DIAGRAM



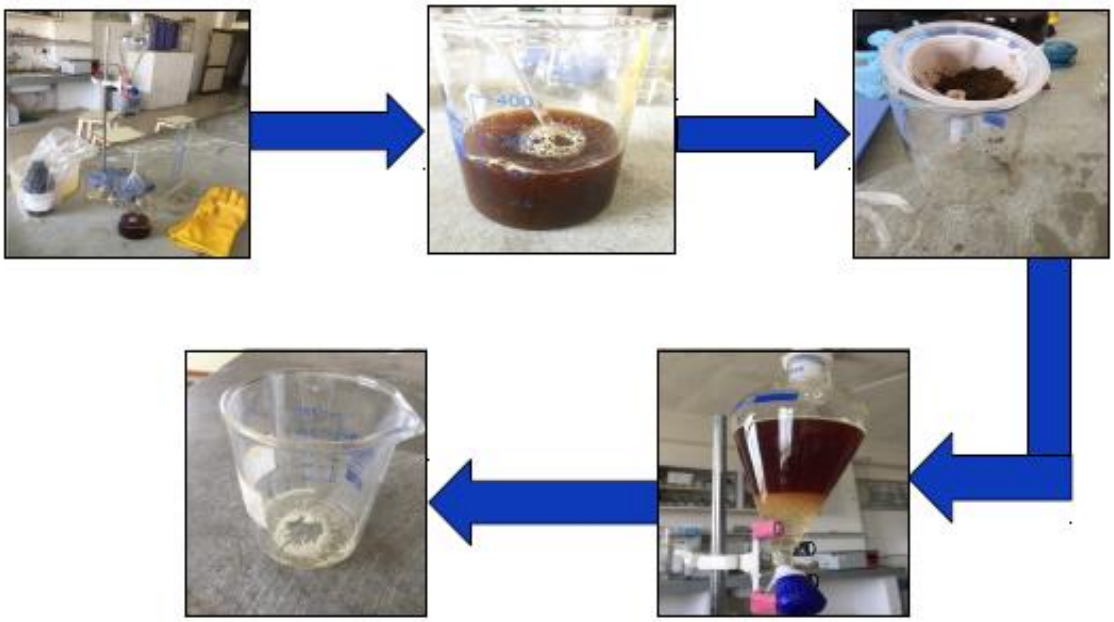
(Flow diagram of the process)

2.4 STEPWISE PROCEDURE

- Before starting a process, a perfect laboratory set-up required. All the materials and reagents which are required for the process must be collected together before starting an experiment/process.
- Firstly, a particular amount of tea will be taken and it will be added to the measured quantity of distilled water. After addition of tea into the water, the solution will be heated on the hot plate to the approx. 200-250ºC temperature for minimum 15-20 minutes.
- After heating, the solution must be filtered to get a proper tea solution. When the filtration can be done, the solution must be put into the water bath (20ºC) for minimum 5-10 minutes.
- Filtered tea solution will be poured to the separating funnel. After tea solution is poured, dichloromethane will be added to the separating funnel accordingly. As dichloromethane is non-polar and water is polar, they will not mix together and forms a layer.
- After mixing of dichloromethane, shake the funnel vigorously. Open the nob of the funnel after 30 seconds to release the pressure. After shaking, let the funnel on stand to settle down the mixture.
- After some time, two separate layers will be formed, one is tea solution and the other one is dichloromethane solution with caffeine.
- Caffeine content in tea solution will be extracted in dichloromethane as caffeine is more soluble in dichloromethane than the water. All the caffeine in tea solution will be extracted in dichloromethane by performing this step 2-3 times.
- Dichloromethane and caffeine solution will be separated out from funnel to get a caffeine from it. Drying of that solution is important to get a caffeine powder. As dichloromethane is volatile at atmospheric condition, it will be evaporated after certain time. So, there is no need of drying.
- After drying/evaporation of dichloromethane, we will get the pure powder caffeine.

(Final product i.e. caffeine)

2.5 SYSTEM FLOW WITH EXPERIMENTAL SET-UP



3. INDUSTRIAL APPLICATIONS OF CAFFEINE

- Food and pharmaceuticals (as an additive and stimulant)
- Added to sodas and energy drinks
- Chewing gums, sports gels
- Pain relievers, cold medicines
- Tooth enamels
- Preservatives

3.1 SOCIAL BENEFITS

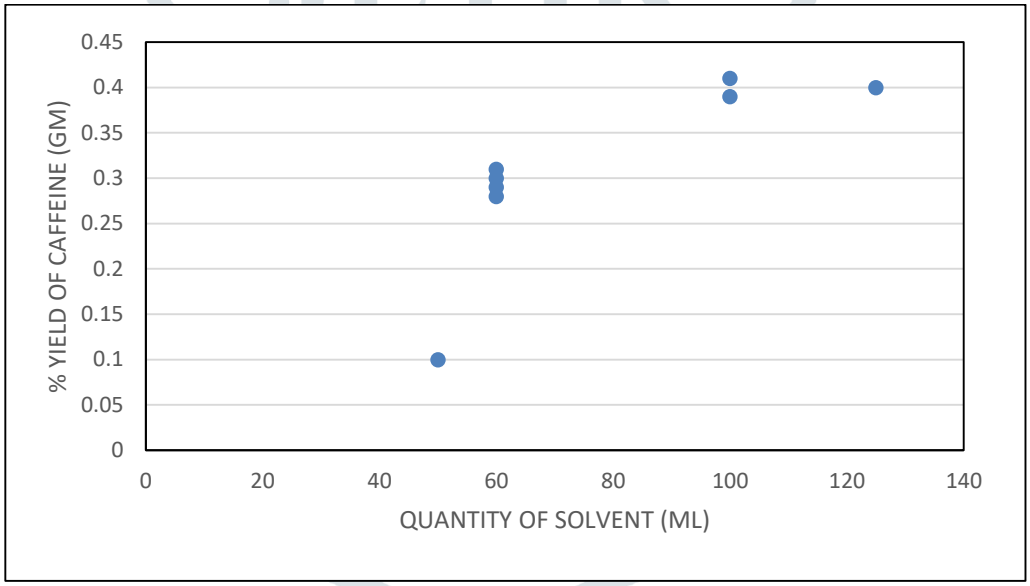
- Lowers blood pressure
- Better sleep
- Better mood
- Decreases anxiety
- Fewer headaches
- Healthier teeth
- Antioxidant
- Healthier diet
- Stop jitters
- Decreases the risk of cardiac events
- Increases productivity
- Reduces the risk of type 2 diabetes
- Better health
- Medicines

4. RESULTS AND EVALUATION

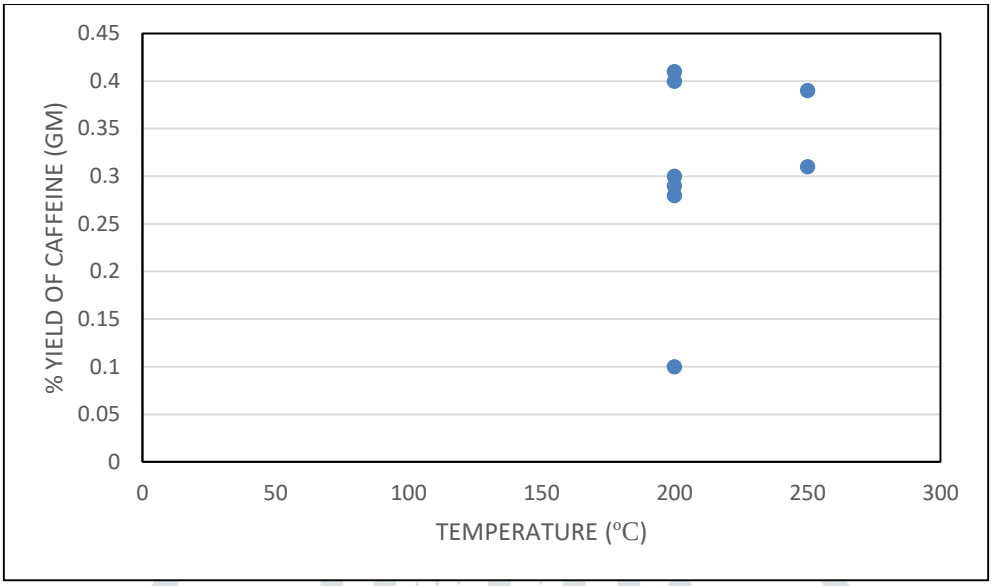
4.1 EXPERIMENTAL DATA

SR. NO.	QUANTITY OF TEA (gm.)	QUANTITY OF WATER (ml)	TEMPERATURE (ºC)	QUANTITY OF TEA SOLUTION (ml)	QUANTITY OF DCM (ml)	DCM + CAFFEINE SOLUTION (ml)	QUANTITY OF CAFFEINE (gm.)
1.	5	200	200	170	20*3	45	0.30
2.	5	200	200	171	20*3	49	0.29
3.	5	200	200	169	25*2	40	0.1
4.	5	150	200	165	20*3	42	0.28
5.	5	200	250	172	20*3	49	0.31
6.	5	200	250	171	20*5	61	0.39
7.	5	200	200	170	25*5	59	0.40
8.	5	200	200	169	20*5	60	0.41

4.2 GRAPHICAL REPRESENTSTION



(Qty. of solvent v/s yield of caffeine)



(Temperature v/s yield of caffeine)

5. CONCLUSION

As per the experiments and the data collected by changing different parameter like temperature and quantity of the solvent, we can conclude that

- % yield of caffeine increases with increase in the quantity of solvent i.e. dichloromethane
- % yield of caffeine is increasing with increase in the temperature.

By using this process, one can reduces the cost of the overall production by half of its existing price.

After the evaluation of results and all the data, we can say that this process gives maximum yield in the extraction process of caffeine from tea. We can also conclude that this process is easy to operate, durable and cost effective compared to other processes.

6. ACKNOWLEDGEMENT

I would like to thank my faculties of chemical engineering department who gave me a worthy support during the whole study. This study is not possible without a guidance of Prof. Niharika Nath who gave her qualitative suggestions and inspired me to do this. I am also thankful to my instructors and friends for their motivation and helpful advices. I would like to thank my parents for their unconditional love and support which gives me an extreme courage. Thanks to all of them who directly or indirectly supported me in this work.

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