



ISSN Print: 2394-7500  
ISSN Online: 2394-5869  
Impact Factor: 5.2  
IJAR 2015; 1(9): 822-824  
www.allresearchjournal.com  
Received: 09-06-2015  
Accepted: 12-07-2015

**Revaz Melkadze**  
Institute of Machine Mechanics  
(Georgia, Tbilisi).

**Paata Dolidze**  
Institute of Machine Mechanics  
(Georgia, Tbilisi).

**Ketevan Kintsurashvili**  
Akaki Tsereteli state university  
(Georgia, Kutaisi).

## Method for Producing Caffeine from Tea and Express-Method of Its Testing

**Revaz Melkadze, Paata Dolidze, Ketevan Kintsurashvili**

### Abstract

The article describes the results of laboratory experiments designed to produce caffeine from tea material by "dry" extraction of raw materials and the rapid method for the analysis of caffeine. It is shown that the method of dry sublimation of caffeine is technologically cheap and easy to implement in terms of any enterprise of small and medium power.

**Keywords:** tea, "dry" extraction, caffeine, method of determination.

### 1. Introduction

From numerous bioactive complexes and separate substances of plants, causing different pharmacological actions, undoubtedly important are alkaloids, and from them – purine connections the main representative of which is caffeine (1, 3, 7 –triethyl xanthine).

Caffeine is a powerful natural stimulator which is used for increase of endurance and physical force during trainings. It belongs to the class of nootropic substances as it increases sensitivity of neurons and, thus, stimulates mental facilities. At systematic use of caffeine the risk of development of Altsmeyer's disease, cirrhosis and cancer of a liver decreases. The main mechanism of effect of caffeine is in its antagonism to adenosine receptors; the last possesses the sedative and weakening action and (important) not the last role in which play its receptors located in the brain. Caffeine inhibits action of adenosine, doing us more vigilant, attentive and vigorous, thus begin acting dopamine, serotonin, acetylcholine and adrenaline.

Caffeine - the wide psychoactive agent which is most consumed in the world which, unlike many other psychoactive agents, is lawful and unregulated almost worldwide. The drinks containing caffeine such as coffee, tea, soft and energy beverages, are very popular.

World consumption of caffeine is estimated at 120 000 tons per year that makes it the most popular psychoactive agent in the world. On average, this quantity is one portion of the caffeine drink for each person every day.

The main natural sources of caffeine are Tea, Coffee, Cocoa, Cola, Ilex Paraguerinsis, Paulinia cupana, Guarani, Sterculia platanifolia etc. <sup>[1, 3]</sup>.

Tea resources in Georgia are great that gives the chance to provide in caffeine not only needs of the pharmaceutical and food industry, but the subject of import at organization of the corresponding production on the basis of highly effective technology and techniques.

In industry caffeine is received in two ways: in chemical way from uric acid and from vegetable raw materials.

The extraction method is the base of industrial release of caffeine from vegetable raw materials.

Process of extraction includes three consecutive stages: mixture of initial mix of substances with an extractant; mechanical division (stratifying) of two formed phases; removal of then extractant from both phases and its regeneration for the purpose of repeated use. After mechanical division is obtained solution of the extracted substance in the extractant (extract) and the rest of initial solution (raffinate) or strong substance. Allocation of the extracted substance from the extract and at the same time regeneration of the extractant is made by distillation, evaporation, crystallization, salting and by other methods.

As an extractant for extraction of caffeine from vegetable raw materials the hot ethyl

**Correspondence:**  
**Ketevan Kintsurashvili**  
Akaki Tsereteli state university  
(Georgia, Kutaisi).

alcohol is used. Further evaporation of alcohol, dissolution of the obtained concentrate in water and extraction by chloroform lead to transition of caffeine to the organic phase. The given method is characterized by essential shortage that lies in the use of highly toxic solvents that negatively effects on ecology.

For elimination of these shortages we offered significantly new reception of receiving caffeine from vegetable raw materials containing caffeine by dry extraction (sublimation) of the material.

Besides, development of the method of fast and its full value control in the full cycle "raw materials-finished goods" is important.

The method of quantitative definition of caffeine [4-10] existing now is very labor-consuming, long (the general duration of definition takes 5 hours) and, partly, subjective.

In return of the existing one we have developed the spectroscopic method of definition of caffeine in the extracts released from strongly absorbing tannin.

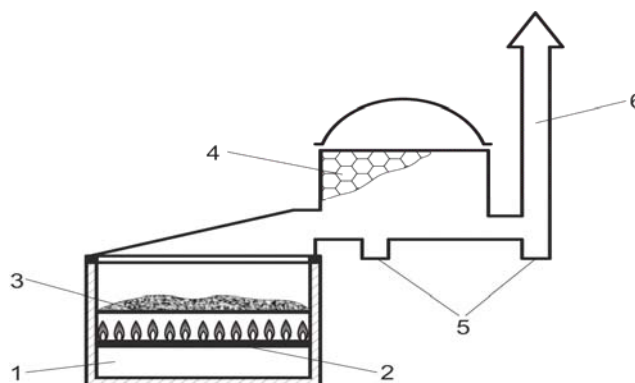
Results of the search works carried out by us on caffeine extraction by the method of contact extraction – dry sublimation on the laboratory installation made for this purpose (drawing) and checks of the express- method of its testing offered by us are given below.

**2. Materials and Methods**

For sublimation of caffeine was developed a laboratory installation, the schematic diagram of which is given in Fig.1.

For experiments previously was made the mix of 80-95% of

waste of tea production and 5-20% of the plantation forming material being dried up to 7-9% of residual humidity. In view of low heat conductivity of the tea material for uniformity of Its warming up was added the river dry sand on weight one and a half times more than the loaded material. Heating of the material was conducted within 24 hours at a temperature in the receiver 110-120 0 C. Fumed caffeine with products of dry distillation and vapors of water passed in the receiver camera where crystals of caffeine settled on grids. Other gases passed through the second office (section) passed in the taking-away pipe. Results of experiments are presented in Tab. 1.

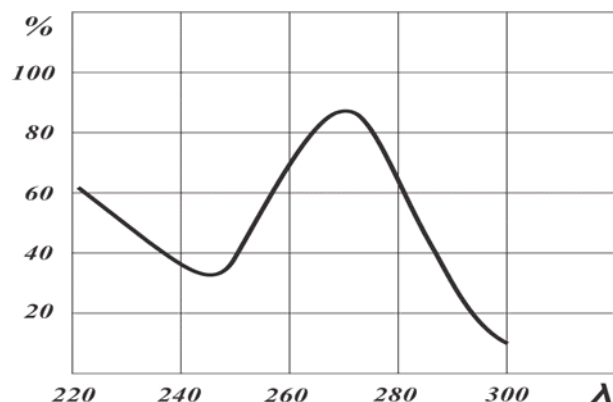


**Fig1:** Laboratory installation for caffeine sublimation  
 1- combustion chamber; 2- furnace; 3 - mix of tea material with sand; 4 - Receiver of caffeine; 5- collectors for pitch; 6 - chimney

**Table 1:** Results of sublimation of caffeine from a different type of tea material

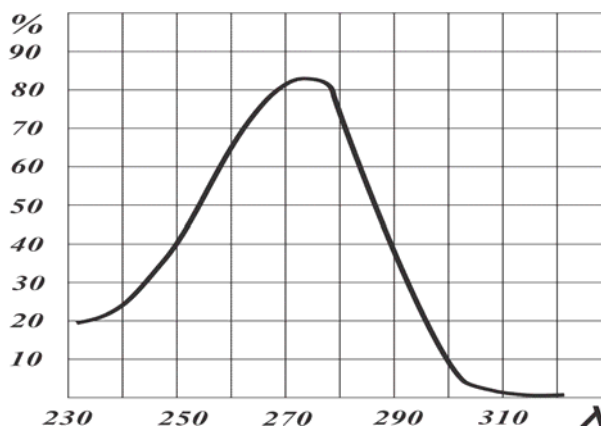
#	Mix composition		Sub- limate time, hour	Tempera-ture in the receiver, 0 C	The content of caffeine in initial material, % for the dry substance	Exit of caffeine	
	Name of material	Quan-tity, g				g	%
1	- cutting of green tea	480	2	100-110	1,30	2,55	16,0
	- dust of black tea	465			2,09		
2	- waste of black tea	500	6	110-120	1,68	3,00	21,6
	- waste of green tea	250			2,20		
3	- waste of green tea (" plates")	600	13	100-110	1,56	4,49	30,2
	- waste of black tea (wit, dust)	250			2,20		

For research of the method of definition of caffeine the curve of absorption of pure caffeine in water was constructed (4 mg of caffeine in 100 ml of water). The method is based on the extracting ability of caffeine in chloroform (Fig. 2).



**Fig 2:** Absorption curve of pure caffeine in water

In Fig. 3 and 4 are given the absorption curve and calibration curve of pure caffeine in chloroform (4 mg caffeine + 100 ml chloroform).



**Fig 3:** Absorption curve of caffeine in chloroform

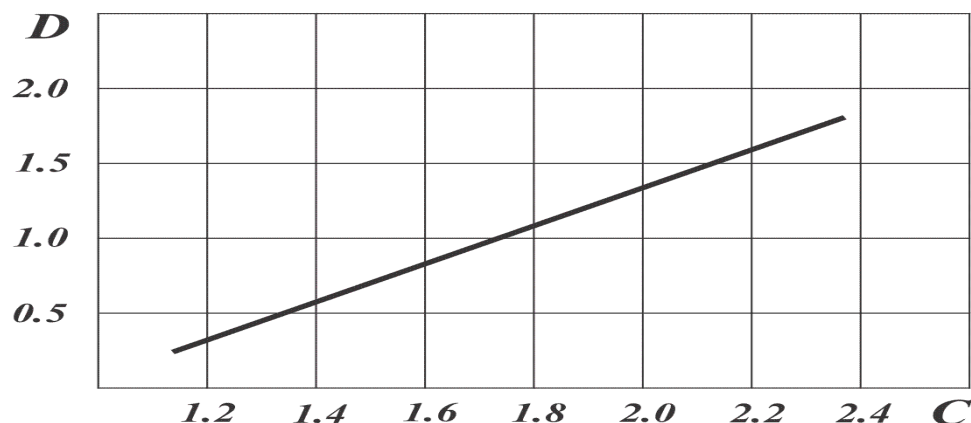


Fig 4: Calibration curve of pure caffeine in chloroform

As a raw material was used a green tea leaf in which was made definition of the content of caffeine on the SF-10 spectrophotometer and according to the standard method. Results are presented in Tab. 2.

Table 2: Comparative indicators of the definition methods of caffeine

##	Dry weight of a hinge, g	The optical density, D	Concentration, mg/g on the calibration curve	The content of caffeine, in %, on SF-10 (SF)	The content of caffeine, in % on a standard method (SM)	Parity SM/SF, %
1	0,90	1,61	32,7	2,04	2,05	100,4
2	0,90	1,67	33,1	2,6	2,26	109,7
3	0,90	1,04	34,0	1,59	1,99	125,1
4	0,91	1,81	35,5	2,10	1,78	84,7
5	0,93	1,84	36,0	1,85	2,01	108,8
6	0,92	1,62	32,8	1,98	1,85	79,7
7	0,91	1,74	33,6	2,05	1,79	87,3
X <sub>n</sub>	0,91	1,62	34,0	1,95	1,92	98,5

### 3. Results and Their Discussion

- At dry sublimation the greatest number of caffeine (with impurity of resinous substances) turns out at 13 hours lasting active sublimate, thus the maximum exit of caffeine makes 30,2% of its initial contents in the raw material.
- It should be noted that exit of caffeine in the conditions of the carried out experiments is quite low. It generally is explained by constructive shortcomings of the subliming device that should be considered when developing the pilot- experimental installation.
- The spectrophotometer method of definition of caffeine with high degree coincides with results of the standard method, thus the time of analysis for SF-10 makes 0, 5 min., i.e. the speed of definition depends on time of receiving extract (20-25 minutes).

### 4. Conclusions

- Adjusting of industrial receiving of caffeine from tea material and waste of processing of tea has a great national-economic value providing waste-free production.
- The method of receiving caffeine we proposed by dry sublimation of material is the most simple and economic.
- The spectrophotometer method of definition of caffeine allows very quickly (in 25 minutes against 4-5 hours) to carry out the analysis with high degree of reliability.
- The offered method can be applied successfully in analyses and other vegetable raw materials and products (soft drinks on the tea basis, energy drinks, tonics, etc.) containing caffeine.

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