

## COFFEE ACID IN SOLUTION

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### ABSTRACT

*In this paper we developed the kinetic method for the determination of micro amount of acid in the coffee solution. The reaction is based on oxidation of acid in the coffee under the influence of hydrogen-peroxide in the presence of Cu (II) ions as catalyst. Examined were in the spectral properties of the system components and their mixtures. Optimal reaction conditions were playing. The calibration is linear and can be applied for determination of acid in the coffee solution in the concentration range from 1.94 to 19.4  $\mu\text{gcm}^{-3}$ . The relative error of determination ranges were from 2.77 to 4.15% in the investigated concentration range.*

**Keywords:** Coffee, coffee acids, kinetic method.

### 1. INTRODUCTION

Coffee plant was originally found and cultivated by Oromo people in the Kafa province of Ethiopia from which it got its name. Around 1000 A.D., Arab people took the coffee seeds from this region and started the first coffee plantation there and then from these it spread to the whole Europe [1].

So, Ethiopia was the origin of coffee and is world's third largest coffee exporter after Burundi and El Salvador. Jimma zone is one of the areas in Ethiopia where coffee-processing plants are in large number. In this zone, wet coffee processing method has been adopted. Wet coffee processing procedure requires the mechanical removal of the pulp with the help of water which produces considerable amount of wastewater [2]. The water used for de-pulping of the cherries is known as pulping water and it accounts for over half of the water used in the process [3].

The wastewater generated from coffee processing plant contains organic matter like pectin, proteins and sugars [4]. Pulping water can further be reused for de-pulping of the harvest of same day but this results in further increase in organic matter and a decrease in pH [5]. The high acidity of this effluent may deplete the life supporting oxygen of the water bodies it is joining [6].

It has been found from literature that the wastewater from such type of industries has high concentration of organic pollutants [7] and is very harmful for surrounding water bodies, human health and aquatic life if discharged directly into the surfacewaters [8]. It was also found from previous studies that only little work has been done to analyse various aspects of coffee processing and about the impact of such effluent on surrounding environment and human health. Thus, there is a need to develop economically viable and eco-friendly technology for handling such type of wastewaters [9].

The aim of this paper is to develop a new kinetic method for determination of micro amount of coffee acid in pharmaceutical preparations. Kinetic spectro-photometric methods of chemical analysis are

relatively rapid and selective enough for the determination of small concentrations of various substances in solution. In addition, it does not require expensive equipment and generally use readily available reagents, making them suitable for using in laboratory conditions.

## 2. EXPERIMENTAL

For examination of coffee were used a several acid solution with concentration of  $1 \times 10^{-3} \text{ molL}^{-1}$  prepared by dissolving the appropriate weight of coffee acid, produced by Merck p.a. The basic solution of NaOH ( $c = 0.1 \text{ molL}^{-1}$ ) was prepared by measuring the specific mass of NaOH (Merck p.a.) and dissolving in water with special condition. Working solution was made before the start of primary dilution. The basic solution of Cu (II) ( $c = 1 \times 10^{-3} \text{ molL}^{-1}$ ) was made by dissolving a certain mass of  $\text{CuCl}_2$  (JT Baker, p.a.). The working solution of Cu (II) ( $c = 1 \times 10^{-4} \text{ molL}^{-1}$ ) was made before the dilution of the base. The working solution of  $\text{H}_2\text{O}_2$  was made just prior to dilution of 30%  $\text{H}_2\text{O}_2$  solution with  $c = 0.442 \text{ molL}^{-1}$ , produced by Merck.

Selected volumes of reactants were weighed in the flask by pipetting of  $10 \text{ cm}^3$ . Stirring moment marked the beginning of the reaction as evidenced by chronometer. The solution was then transferred into the measuring cuvette of the spectrophotometer. Absorbance readings were performed at selected wavelengths for every 30s during 5 minutes and start it after the first or second minute, depending on the system. Graph  $A=f(t)$  represents the kinetic curve.

The equipment used for testing the kinetic reaction are UV/Vis spectrophotometer, model Agilent 8453 with a furnace length of 1cm optical path absorption spectra recording and monitoring absorbance changes with time in determining the acid in coffee; the thermostat, model Julabo MP 5A used for thermo stabilities of solution; analytical balance model Mettler Toledo AB-204-S used for the measurement of solid substances; pH meter Hanna Instruments model used for measuring the pH value of solution; MicroMed high purity water system manufactured from TKA Wasseraufbereitungssysteme GmbH, used to obtain demineralized water; variable automatic pipettes Lab Mate used for pipetting solutions and chronometer used for measure of time.

## 3. RESULTS AND DISCUSION

For selecting the optimal wavelength absorption spectra were recorded reactants, reaction intermediates or products. For the processing of kinetic parameters was applied differential variant tangents method on the linear dependence of absorbance of the solution reactions on time.

In order to determine the optimal reaction conditions concentration of one of the components was changed while others were constant. After determining the optimal reaction conditions ( $C_{\text{NaOH}} = 1 \times 10^{-2} \text{ molL}^{-3}$ ,  $C_{\text{Cu(II)}} = 2 \times 10^{-6} \text{ molL}^{-3}$ ,  $C_{\text{H}_2\text{O}_2} = 1,326 \times 10^{-2} \text{ molL}^{-3}$ ) variation of the concentration of coffee acid, in interval of 1.94 to  $19.4 \mu\text{gcm}^{-3}$ , was performed. Measurement of absorbance was performed at wavelength  $\lambda = 345 \text{ nm}$ .

Figure 1 shows the linear curves which demonstrate dependence of the rate of chemical reaction from coffee acid concentration at three different temperatures of  $20^\circ \text{C}$ ,  $25^\circ \text{C}$ ,  $30^\circ \text{C}$ . Curves are present with equations:

$$\begin{aligned} y &= 0,2387x - 0,1214, \quad R^2 = 0,9984, \quad t = 20 \pm 0,1^\circ\text{C} \\ y &= 0,2625x - 0,1168, \quad R^2 = 0,9984 \quad t = 25 \pm 0,1^\circ\text{C} \\ y &= 0,287x - 0,0847, \quad R^2 = 0,9982 \quad t = 30 \pm 0,1^\circ\text{C} \end{aligned}$$

$y$  - rate of chemical reaction

$x$  - concentration of coffee acid

$R$  - coefficient of reproducibility

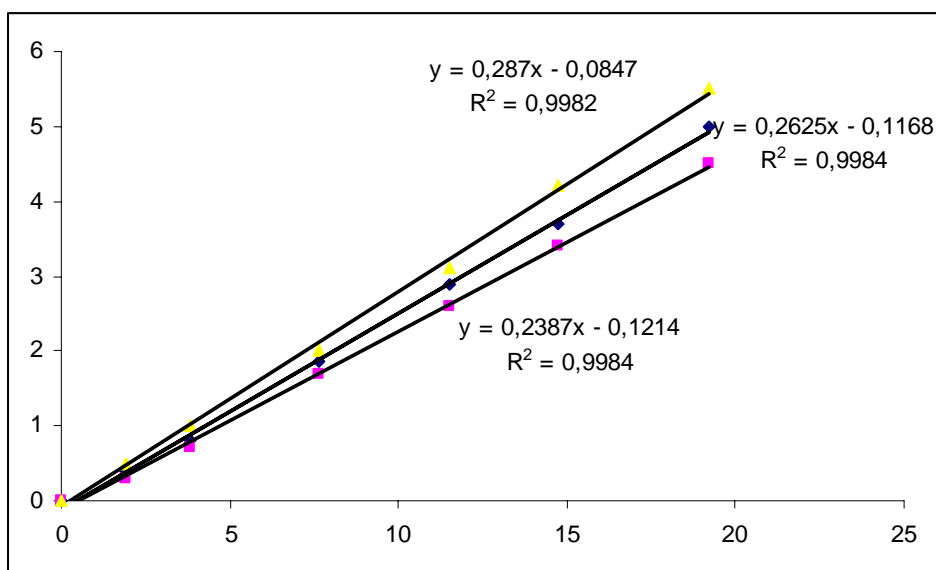


Figure 1. Dependence of the rate of chemical reaction from coffee acid concentration at different temperatures.

The calibration (Fig. 1) is linear and can be applied for determination of coffee acid in the solutions in this concentration range. On the basis of kinetic equations rate constants are calculated at three different temperatures (Table 1):

$$\frac{dc}{dt} = k \cdot c_{NaOH}^{0.8} \cdot c_{Cu(II)}^1 \cdot c_{H_2O_2}^{-0.7} \cdot c_{CA}^1$$

Table 1. Kinetic rate constants at different temperatures

$k \cdot 10^8 \text{ (mol} \cdot \text{dm}^{-3})^{1-n} \text{ s}^{-1}$	T (K)
4.00	293
4.37	298
4.88	303

#### 4. CONCLUSIONS

In this paper we developed the kinetic method for the determination of micro amount of acid in the coffee solution. The reaction is based on oxidation of acid in the coffee under the influence of hydrogen peroxide in the presence of Cu (II) ions as catalyst. We were examined the spectral properties of the system components and their mixtures.

After determining the optimal reaction conditions we made a conclusion that the calibration law is linear and can be applied for determination of coffee acid in the solutions in given concentration range. We also carried out investigation of the temperature influence on the rate of reaction and we found that the maximum of rate constant is obtained with the highest temperature.

## 5. REFERENCE

- [1] K. Adams, Coffee Development and Management Techniques, Ministry of coffee and Tea development, Addis Ababa, 1980.
- [2] J.C. Von Enden, Best practices at wet processing pay financial benefits to farmers and processors, GTZ-PPP Project on Improvement of coffee quality and sustainability of coffee production in Vietnam, 2002.
- [3] K.V. Narasimha Murthy, D.S. Antonette, G. Kapur, An Effluent Treatmentcum-Electricity Generation Option at Coffee Estates: Is It Financially Feasible? Draft version, International Energy Initiative, Bangalore, 2004.
- [4] J. Fresner, H. Schnitzer, How coffee-making can help one understand cleaner production, *J. Cleaner Prod.* 4 (3–4) (1996) 213–217.
- [5] R. Bello-Mendoza, M.F. Castillo-Rivera, Start-up of an anaerobic hybrid UASB filter reactor treating wastewater from a coffee processing plant, *J. Anaerobe Environ. Microbiol.* 4 (1998) 219–225.
- [6] K.C. Calvert, The treatment of CoffeeWastewater, The Biogas Option—A Review and Preliminary Report of Ongoing Research. Coffee Research Report (50). Coffee Industry Corporation Ltd. Kainantu, Papua New Guinea, 1997.
- [7] M.R. Adams, J. Dougan, Coffee Technology, John Wiley and Sons, New York, 1987.
- [8] C. Chapman, Water Quality Assessments. A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring, Chapman and Hill, London, United Kingdom, 1996.
- [9] Ministry of Environment and Forest (MoEF), 2003. Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003, Ministry of Environment and Forests, Government of India, New Delhi.