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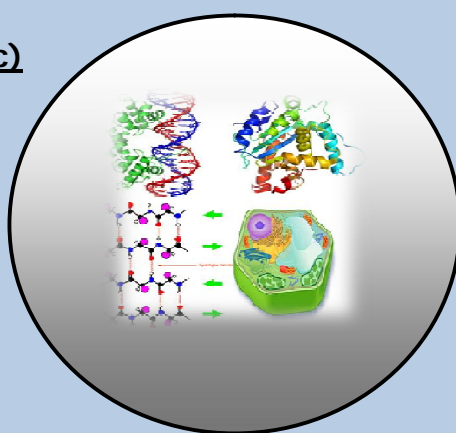
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**RESEARCH PAPER**

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**Determination of Concentration Level of Tin (II) in  
Canned Juice Vended in Local Shop in Jimma Town using  
Cyclic Voltametry**

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**ABSTRACT**

*It has been reported that tin-plate is widely used in food industry as packing's of canned foods. Tin is a heavy metal element which can do certain harm to human health. Many methods have been developed for the determination of tin e.g., spectrophotometry, atomic absorption spectrometry, polarography and voltametry, single-sweep polarography. However, not all of them are suitable for routine trace determinations. In this report, we were investigate the electrochemical behavior of tin (II) in  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  by a cyclic voltametry. Cyclic voltametry in a potential window of -700 V to -300 V was used to determine concentration of tin (II) in the samples. The procedure involved was standard addition method which is characterized by sensitivity, cheapness and also offers convenient measurement of low concentration of tin. The observed value of ( $\text{Sn}^{2+}$ ) for Mango, Orange and Apple were noted. It was found that only orange, that shows a comparable concentration of trace tin with the permutable amount set by WHO.*

**Key Word:** Tin-Plate, Electrochemical Behavior, Atomic Absorption Spectrometry Cyclic Voltametry, Potential, Standard Addition and Concentration.

## INTRODUCTION

Tin (Sn) is natural element in the earth's crust and characterized by soft, pliable, silvery white metal, not easily oxidized, resistant to corrosion does not dissolve in water but attacked by alkali and acid salt. It combines with other chemicals to form compound. Combination with chemical like chlorine, sulfur or oxygen are called inorganic tin compound and also it can combine with carbon to form organic tin compounds. Tin metal, in organic tin compounds can be found in air, water, and soil near place, and in food stuffs according to ATSDR (2005). Tin has been extensively used in industry for last five decades. One of biggest utilizes of tin is widely used in food industry as *packaging* of canned food, for coating other metals, to line inside of beverage cans and food container, in tooth paste, perfumes, soaps, food additives and dyes as stated by Food RA Guide to the UK Regulations (1981). The main source for tin up take by man is food or drinking liquid from tin lined cans (today greater than 90% of tin-lined cans used for food are protected with Tin layer) however the *maximum tolerance permitted limit* of Sn by WHO is  $250\mu\text{g/g}$ , S. M. Sabry et al. (1999). Human and animal studies shows that ingestion of large amount of tin compounds can cause stomach, anemia, liver and kidney problems. Some organic tin compounds such as dibutyl and tributyl tins, have been shown to attack the reproductive and immune system in animals, but this has not been examined in people. Breathing swallowing or skin contact with organo tin and inorganic tin compounds can interfere with the way the brain and nervous system work. In several cases it can cause skin and eye irritation and death. Determination of trace tin in canned food is great importance as some of them have nutritional significance, whilst others are toxic, S. B. Adeloju et al (1991). Most food contain very low concentration of tin, usually bellow  $10\text{ mg/kg}$ , canned foods can contain higher concentrations, which may increase with time as a result of gradual dissolution in to the food cans to protect the steel body of the cans from corrosion. Canned food frequently contains high concentration of tin. This is particularly true for acid food- stuffs such as canned fruit juices high concentration of tin affects the flavor of juices and also cause diarrhea and irritates digestive tract. Generally tin-plate is widely used in food industry as packing's of canned foods. Tin is a heavy metal element which can do certain harm to human health. Many methods have been developed for the determination of tin. For example: - spectrophotometry, atomic absorption spectrometry, polarography and voltametry, single-sweep polarography.

However, not all of them are suitable for routine trace determinations. In this report, we were investigate the electrochemical behavior of tin (II) in  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  by a cyclic voltametry J. Wang, J. Zadeii et al (1987). We used standard addition method which is characterized by sensitivity, cheapness and convenience, for the determination of *trace* tin in juices of canned fruits with satisfactory results F. Heppeler et al, 1996

## MATERIAL AND METHODS

### Reagent and Chemicals

The following chemicals were used during the experiments as 1M HCl, Concentrated  $\text{H}_2\text{SO}_4$ , Concentrated  $\text{HNO}_3$ , hydrated  $\text{SnCl}_2$ , tin (II) ion stock solution (juice) and all the chemicals are analytically grade.

### Apparatus and Instrument

The following apparatus and instruments were used during the experiment as Cyclic voltammeter, platinum electrode, Reference electrode ( $\text{Ag}/\text{AgCl}/$ ), Auxiliary electrode Pt coil.

### Sampling

#### Sample collection

Samples of 23 shops were selected and Mango, Orange and Apple canned juice was collected from each.

#### Sample preparation

0.1M of  $\text{Sn}^{2+}$  standard stock solution was prepared by dissolving 2.2563 gm of  $\text{SnCl}_2$  in 100 ml of 1MHCl.

#### Sample digestion

10 ml of each canned juice sample (Mango, Orange and Apple) was transferred to 100 ml conical flask respectively. Then 2.5 ml of concentrated  $\text{HNO}_3$  and 1ml of concentrated  $\text{H}_2\text{SO}_4$  were added. Then after the sample was carefully heated and evaporated to 1 ml dryness and cooling, the digested sample was neutralized by NaOH solution. Then the solution was transferred to 100 ml conical flask. .

### Procedures

Mango, Orange and Apple sample solutions were prepared through digestion in 100 ml conical flask respectively. 0.008mm of standard  $\text{Sn}^{2+}$  solution was prepared from  $\text{SnCl}_2$  stock solution. Assuming that the amount of trace tin in the sample solution is small the standard addition method was used to all samples indicated below

**Table 1. The same 0.008mM of standard solution was used for each sample.**

S/N	Volume of sample (m1)	Volume of standard (m1)	Diluted in volume (m1)
1	10	0	30
2	10	3	30
3	10	6	30
4	10	9	30

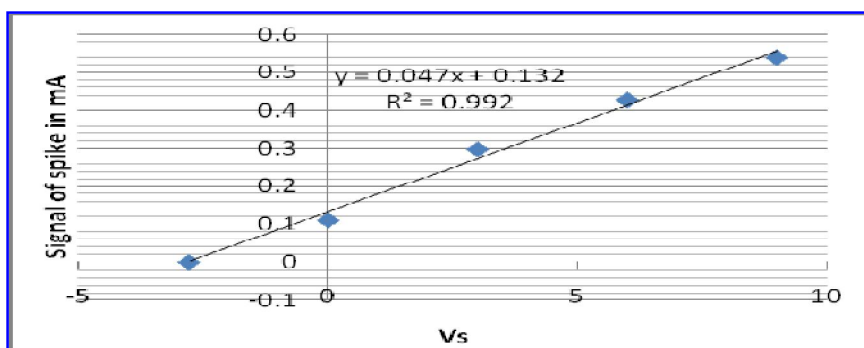
A potential window of (-300 V to -700 V) were adjusted on the CV BAS, and then the supporting electrolyte HCl was run in order to check the interface in the given potential window. Each sample was analyzed using cyclic voltammetry and their spike current in mA was recorded.

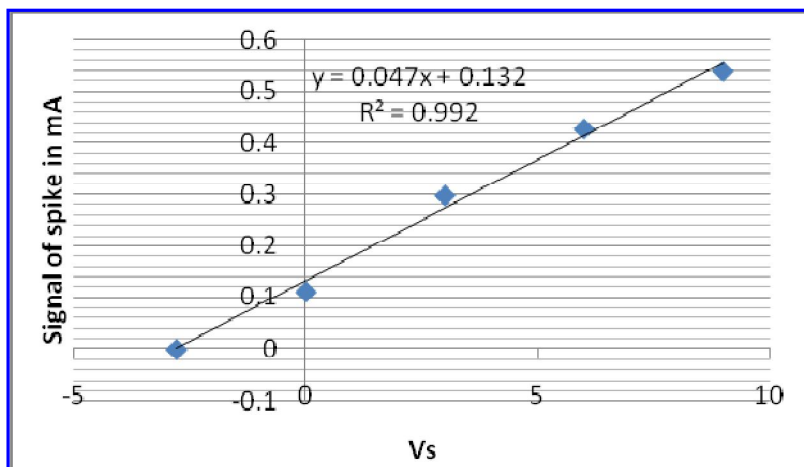
## RESULTS AND DISCUSSION

In the determination of the concentration of tin (II) from juice samples (Mango, Orange and Apple) in the same potential window (-700 to -300) V, and the same 0.008 mM concentration of standard solution, the standard addition method was used. The recorded results was tabulated as can be seen in the following tables for each samples

**Table 2. The current in mA of each of the sample.**

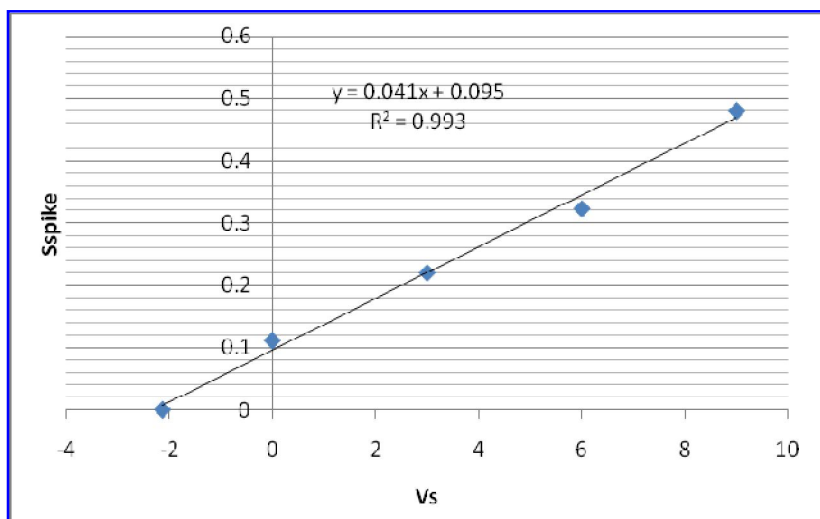
S.No	Sample volume in ml	Standard volume in ml	Current in mA		
			Mango	Orange	Apple
1	10	0	0.1112	0.1112	0.1112
2	10	3	0.2983	0.2650	0.2204
3	10	6	0.4289	0.4001	0.3234
4	10	9	0.5401	0.5180	0.4809

**Figure 1. Calibration curve for Mango sample.**



**Figure 2. The calibration curve for the orange sample.**

*Calibration curves for method of standard addition.* The signal is plotted versus volume of the added standard for three samples. The X-intercept is calculated by dividing the product of concentration of the analyte and volume of the sample to the concentration of the sample and the following results were obtained.



**Figure 3. The calibration curve for the Apple sample.**

Generally as shown in the table1, even if the same procedure followed for three juice samples, the signal of the spike in mA were different for three different juice samples. These shows the samples contain different amount of  $\text{Sn}^{2+}$ .

The calibration curve for three samples in the fig. 2, fig.3 and fig.4 exhibited highly linear behavior in the examined concentration of  $\text{Sn}^{2+}$  ( $R = 0.998, 0.993, 0.992$  for Mango, Orange and Apple respectively)

Table 3 shows that the determined concentration level of  $\text{Sn}^{2+}$  for Mango, Orange and Apple juices respectively. Among three juices samples Mango and Orange showed that  $15\mu\text{g/g}$  and  $3\mu\text{g/g}$  greater than that of *maximum tolerance level* defined by WHO as is the case of Thomas R. Frieden et al (2013). On the other hand the result of Apple showed that  $48\mu\text{g/g}$  lesser concentration of tin than that of maximum tolerance level defined by WHO, for which the health effect should be further studied.

**Table 3. Determined concentrations from the juices.**

S.No.	Juice sample	Sn (II) or $\text{Sn}^{2+}$ in $\mu\text{g/g}$	Permitted limit by WHO
1	Mango	265	250 $\mu\text{g/g}$
2	Orange	253	
3	Apple	202	

## CONCLUSION

Based on the results of the study the following conclusion was made. The studied juice samples contain  $\text{Sn}^{2+}$  metal and their measured value shows not in the normal range of WHO. Especially mango and Orange juices contain greater concentration value than maximum tolerance level organized by WHO. These contribute the consumer health problem. Therefore reducing the amount of canned food product you eat or drink reduces your exposure to tin. Hence further research should be conducted to know the effect of the consumed scanned juice in Ethiopia.

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