Determination of Potassium Iodate in Edible Salt by Potassium Iodide-Iodine-Starch System

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Abstract: In acidic medium, ki can react with kio3 to form i2, then i2 and starch form i2-starch blue complex with a maximum absorption wavelength of 596 nm. Beer's law is obeyed between the kio3 content and the absorbance of i2-starch blue complex. Base on this, the kio3 content can be determined indirectly. A novel method for the determination of potassium iodate in edible salt by potassium iodide-iodine-starch system has been established. The various effect factors on the determination of iodide by potassium iodide-iodine-starch system are investigated in detail. Under optimal conditions, when the mass concentration of kio3 is 0.4000~1.280 μg/ml, the linear regression equation is a=-0.0649+0.04702c (μg/ml) with the linear correlation coefficient is 0.9992. this proposed method had been successfully applied to determinate kio3 in edible salt, and the results agree well with those by standard method.

1 INTRODUCTION

Iodine is one of the essential microelements for humans. It can enhance the basic metabolism and promote the growth and development of human body. Both iodine deficiency and iodine excess do harm to the human body. Iodine deficiency can cause an endemic goiter and potential damage to children's intellectual growth, and iodine excess can lead to hypothyroidism, thyroid enlargement and other clinical manifestations. Eating iodized salt is the most important and effective way to prevent iodine deficiency disease. Potassium iodiate is usually added to the edible salt, which is the iodized salt. Eating iodized salt can achieve the effect of iodine supplement. Thus, the determination of iodine content in iodized salt has great practical significance. So far, the determination methods for potassium iodinate in salt are mainly included titration (Mohammad, 2020), spectrophotometry (Gavrilenko, 2019), emission spectrometry (Yu, 2013), flow-injection (Kuznetsov, 2007), ICP-OES (Sager, 2019), CE-ICP-MS (Chen, 2007) HPLC (Manju, 2010) and so on.

In this paper, a novel method for the determination of potassium iodate in edible salt by potassium iodide-iodine-starch system is reported. In acidic medium, I^- reacts with KIO_3 to form I_2, then I_2 and starch form I_2-starch blue complex with a maximum absorption wavelength of 596 nm. There is a good linear relationship between the absorbance of I_2-starch blue complex and the KIO_3 dosage, the linear equation is A=-0.0649+0.04702C(μg/mL) within the range of 0.4000~1.280 μg/mL KIO_3 concentration. So, by measuring the absorbance of I_2-starch blue complex, the content of KIO_3 can be determined indirectly. This proposed method has been applied to determinate of KIO_3 in edible salt with satisfactory result.

2 EXPERIMENTAL

2.1 Equipment and Reagents

UV-2401 UV-visible spectrophotometer (The Shimadzu Corporation, japan); 723S spectrophotometer (Shanghai Precision & Scientific Instrument Co,. Ltd).

KIO_3 solution: 10.00 μg·mL^{-1}, a 1.000 mg·mL^{-1} potassium iodiate solution is prepared and then

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diluted to 10.00 μg·mL^{-1}. KI solution: 1.000 g·L^{-1}. H_3PO_4 solution: 5.0 mol·L^{-1}. Starch solution:5.0 g·L^{-1}.

All reagents are of analytical reagent grade. Bidistilled water is used.

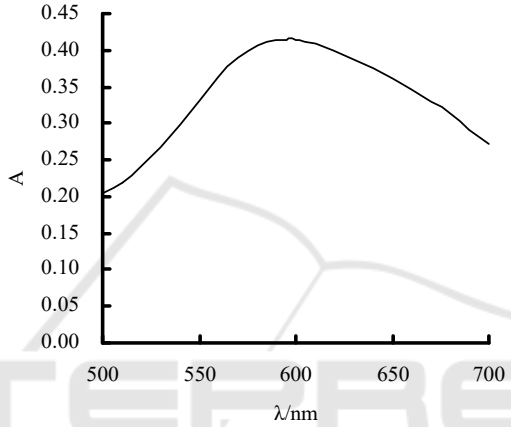
2.2 Method

KI solution 3.00 mL, starch solution 3.00 mL, H_3PO_4 solution 1.50 mL, a certain volume of KIO_3 solution or edible salt sample solution are added into a 25 mL volumetric flask. The solution is diluted to the mark with bidistilled water, mixed well and placed at room temperature for 40 minutes in the dark. The absorbance of I_2-starch blue complex is measured at 596 nm against the reagent blank.

3 RESULTS AND DISCUSSION

3.1 Maximum Absorption Wavelength

In 500 ~ 700 nm, the absorption spectrum of I_2-starch blue complex is obtained using UV-2401 UV-visible spectrophotometer (Fig. 1). Fig. 1 show that the maximum absorption wavelength of I_2-starch blue complex is 596 nm.



KIO_3:2.00 mL; KI:2.00 mL; H_3PO_4:3.00 mL; starch:2.00 mL; reaction time:20 min.

Figure 1: Absorption spectrum.

3.2 Reaction Temperature

The effect of reaction temperature is seen in table 1. We can sen from table 1 that the absorbance of I_2-starch blue complex keep constantly decreasing with the increase of reaction temperature. Hereby, the room temperature is used.

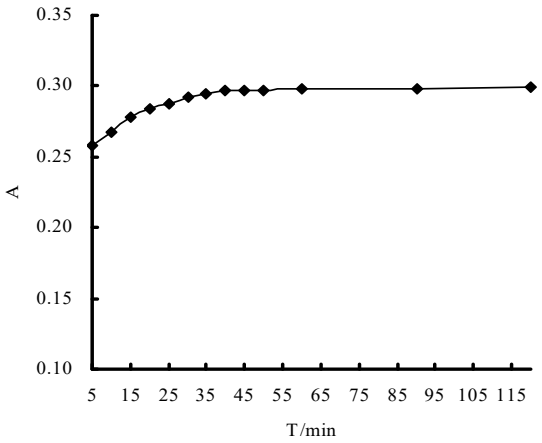
Table 1: The effect of reaction temperature on the absorbance.

Temperature /℃	room temperature	30	35	40
Absorbance	0.380	0.375	0.374	0.372
Temperature /℃	45	50	55	60
Absorbance	0.368	0.364	0.353	0.342

Experimental conditions: KIO_3:2.00 mL; KI:2.00 mL; H_3PO_4:3.00 mL; starch:2.00 mL; reaction time:15 min.

3.3 Reaction Time

The effect of the reaction time is showed in Fig. 2. It is found that the absorbance of I_2-starch blue complex gradually increased with the reaction time, and the absorbance of I_2-starch blue complex reaches greatest when the reaction time is 35 minutes or more. So, 40 minute is selected.

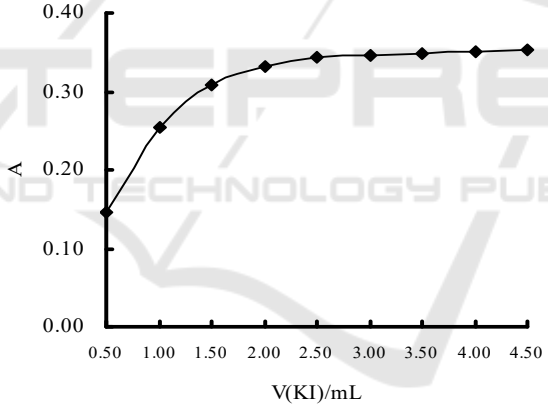


KI:2.00mL; H_3PO_4:3.00mL; KIO_3:2.00mL; starch:2.00mL.

Figure 2: Effect of the reaction time.

3.4 KI Solution Dosage

The effect of KI solution dosage can be seen in fig. 3. The results showed that as the amount of KI increases, the absorbance of I_2-starch blue complex also gradually increases. The absorbance of I_2-starch blue complex reaches the maximum value when KI solution dosage is 2.50 mL. Thereafter, the absorbance of I_2-starch blue is basicly stable as KI dosage increases. Thus, 3.00 mL KI solution is chosed.

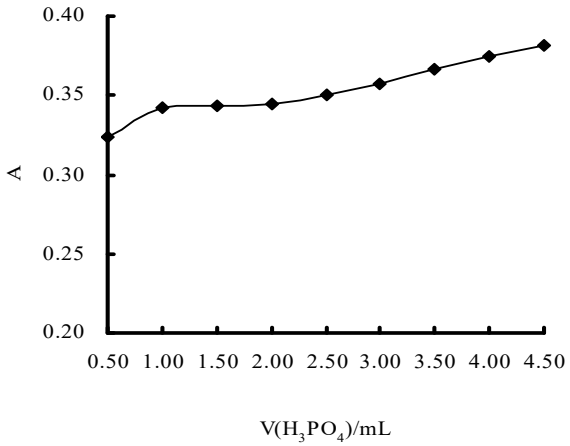


H_3PO_4:3.00mL; KIO_3:2.00mL; starch:2.00mL; reaction time:40 min.

Figure 3: Effect of KI solution dosage.

3.5 H_3PO_4 Solution Dosage

The effect of H_3PO_4 solution dosage is showed in Fig. 4. The results show that the absorbance of I_2-starch blue complex gradually increases with the amount of H_3PO_4 increases. The absorbances of I_2-starch blue complex are essentially constant when the H_3PO_4 solution dosage is 1.00 ~ 2.00 mL. Hence, 1.50 mL H_3PO_4 solution is used.



KI:3.00mL; KIO_3:2.00mL; starch:2.00mL; reaction time:40 min.

Figure 4: Effect of H3PO4 solution dosage.

3.6 Starch Solution Dosage

The effect of starch solution dosage is showed in Table 2. The experimental results show that the absorbance of I_2-starch blue complex increase with the increase of starch solution dosage. The absorbance of I_2-starch blue complex is maintained at stable values when the starch solution dosage is 2.50 mL or more. Therefore, the starch solution dosage is chosen as 3.00 mL.

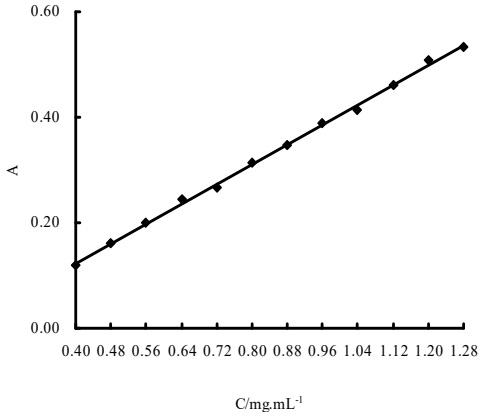
Table 2: The effect of starch solution dosage on the absorbance.

Starch solution dosage /mL	0.50	1.00	1.50	2.00
Absorbance	0.292	0.383	0.395	0.407
Starch solution dosage /mL	2.50	3.00	4.00	5.00
Absorbance	0.413	0.415	0.413	0.414

Experimental conditions: KI:3.00 mL; H_3PO_4:1.50 mL; KIO_3:2.00mL; reaction time:40 min.

3.7 Calibration Curve

Under the optimum conditions, a series of determination solutions with different KIO_3 concentrations are prepared, then the absorbances of these solutions are measured at 596 nm against the reagent blank. Using concentration as the abscissa and absorbance as the ordinate, the calibration curve (Fig. 5) is obtained. In the range of 0.4000-1.280 μg/mL KIO_3, a good linear relationship between the KIO_3 concentration and the absorbance of I_2-starch blue complex, the linear equation is A=-0.0649+0.4702C(μg/mL) and the correlation coefficient is 0.9992.



KI:3.00 mL; H_3PO_4:1.50 mL; starch:3.00 mL; reaction time:40 min.

Figure 5: Calibration curve.

3.8 Sample Analysis

25.0000 g edible salt sample is weighed and dissolved in proper amounts of bidistilled water, then it is transferred into a 250 mL volumetric flask and diluted to the mark with bidistilled water, shaked well. This is the edible salt sample solution.

According to the experimental method, 5.00 mL edible salt sample solution is added, then the absorbance of I_2-starch blue complex is determined, and the content of KIO_3 is calculated. Meanwhile, the recovery tests of standard addition are performed and the content of KIO_3 is determined by standard method. The results as show in Table 3.

Table 3: The content of KIO3 in edible salt.

Sample	Proposed method ($\mu g \cdot g^{-1}$)	RSD (%)	Standard method (GB 26402-2011) ($\mu g \cdot g^{-1}$)	Added ($\mu g \cdot mL^{-1}$)	Recovered ($\mu g \cdot mL^{-1}$)	Recovery yield (%)
Natural sea salt	37.61	0.2	38.82	0.08000 0.1600	0.07614 0.1642	95.2 102.6
Low sodium salt	36.06	0.6	37.15	0.08000 0.1600	0.07571 0.1510	94.6 94.4
Well cooked salt	34.40	0.3	35.45	0.08000 0.1600	0.07512 0.1540	93.9 96.2

From Table 3, we can seen that the content of KIO_3 in edible salt by this proposed method is consistent with the standard method, and the recovery yields are 93.9% ~ 102.6%.

4 CONCLUSION

A novel method for the determination of KIO_3 in edible salt by potassium iodide-iodine-starch system has been reported in this paper. This method has been successfully applied to the determination the content of KIO_3 in different edible salt with satisfactory results. It is obvious that the determination the content of KIO_3 by potassium iodide-iodine-starch system has certain practical significance and foreground of application.

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