

Analysis of Iodine Content in Table Salt

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Abstract

Iodine is an essential nutrient for the human body. It is required by the thyroid gland for producing the thyroxine hormone. Human body lacks the ability to self-produce iodine. Some sources of iodine in food such as seafood, milk, egg, fruits, and vegetables can be consumed to fulfill the daily needs. Table salt is one of the sources of iodine that is routinely consumed. According to SNI No. 3556:2010, table salt must be fortified with 30–80 ppm of potassium iodate. Lack of iodine intake results in a disorder known as the iodine deficiency disorder, which is generally manifested as mumps. This study analyzed the content of iodate in table salt based on the formation of the blue I₂–starch complex. Several optimum conditions were used for this measurement, such as the maximum wavelength, the type and concentration of acid, and the stability time of the complex. Based on the analysis of commercial table salt samples, the results showed that only 50% of our samples contained an appropriate amount of iodine, whereas the remaining samples contained lower or almost no iodine content.

Keyword; table salt, iodine, iodate, I₂–starch complex

Abstrak

Yodium merupakan nutrisi penting bagi tubuh manusia. Hal ini diperlukan oleh kelenjar tiroid untuk menghasilkan hormon tiroksin. Tubuh manusia tidak memiliki kemampuan untuk memproduksi yodium sendiri. Beberapa sumber yodium dalam makanan seperti makanan laut, susu, telur, buah-buahan, dan sayuran dapat dikonsumsi untuk memenuhi kebutuhan sehari-hari. Garam meja adalah salah satu sumber yodium yang dikonsumsi secara rutin. Menurut SNI No. 3556: 2010, garam meja harus diperkaya dengan 30–80 ppm potasium iodat. Kurangnya asupan yodium menghasilkan gangguan yang dikenal sebagai gangguan defisiensi yodium, yang umumnya dimanifestasikan sebagai gondong. Penelitian ini menganalisis kandungan iodat dalam garam meja berdasarkan pada pembentukan kompleks biru I₂-pati. Beberapa kondisi optimum digunakan untuk pengukuran ini, seperti panjang gelombang maksimum, jenis dan konsentrasi asam, dan waktu stabilitas kompleks. Berdasarkan analisis sampel garam meja komersial, hasilnya menunjukkan bahwa hanya 50% dari sampel kami mengandung jumlah yodium yang tepat, sedangkan sampel yang tersisa mengandung lebih sedikit atau hampir tidak ada konten yodium.

Kata kunci: garam meja, yodium, iodat, I₂-pati kompleks

INTRODUCTION

Table salt is a natural additive substance that is essential for sustaining human life. It contains 97.4% of sodium chloride, in addition to a small amount of iodine. Iodine is very important for the thyroid gland and metabolic processes. Table salt is usually fortified with potassium iodate to fulfill the daily requirement of iodine.

Iodine deficiency disorders (IDDs) have been known to occur in several countries across the world, especially in developing countries. Approximately 38% of the world's population is at risk of developing IDDs. IDDs are also one of the nutritional problems in Indonesia. Mumps-endemic areas have been spreading across several regions in Indonesia, such as in Central Java, Bali, East Nusa

Tenggara, and Maluku. The manifestations of IDDs include mumps, hypothyroidism, endemic cretin, impaired mental development, and a low intelligence quotient.

Since the human body cannot produce iodine, a continuous intake of iodine-rich foods is essential. In general, the primary source of iodine for humans is the salt added during food processing. The sources of iodine in food include seafood, meat, milk, eggs, cereals, fruits, and vegetables [4]. Iodine content varies in these foods, such as 200–1000 µg/kg in seafood, 0.1%–0.2% in seaweed, and 20–70 µg/L in milk. The daily requirement of iodine for an adult is between 80 and 150 µg.

According to SNI No. 3556:2010, the content of iodine in table salt must be between 30

and 80 ppm. Therefore, table salt is fortified with potassium iodate or potassium iodide, which is known as the iodization process. This process is useful for the enrichment of iodine content in table salt. Iodine content can be determined using both direct and indirect methods. The direct method is known as iodometry, while the indirect method is known as iodometry. Iodometry is carried out spectrophotometrically by reacting iodate with excess iodide in the presence of an acid. The formed iodine reacts with variamine blue and produces a purple-colored complex, which is measured at 550 nm. Several other methods are also used to determine the iodine content in salt, including ion-pairing HPLC, potentiometric method, epithermal neutron activation analysis, and ICP-MS and spectrophotometric method.

In this study, the content of iodine in table salt was analyzed using the spectrophotometric method through the formation of the blue iodine–starch complex. The blue color was measured using a spectrophotometer at an appropriate wavelength.

MATERIALS AND METHODS

Apparatus

A Shimadzu UV-Vis spectrophotometer Genesys 10S was used for scanning the absorbance measurements and chemical glassware.

Reagents

Deionized water was used for the preparation of solutions. Stock solutions of iodide, iodate, and starch were prepared by dissolving the appropriate amount of KI (Merck), KIO₃ (Merck), starch respectively in deionized water. All chemicals and solvents used were of analytical reagent grade. Working solutions were prepared using appropriate dilutions of the stock solution.

Spectrophotometric Method

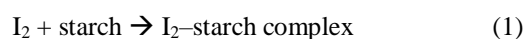
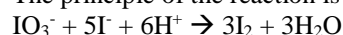
First, the optimization of chemical parameters such as the maximum wavelength, the iodide concentration, the type and concentration of acid, and the stability time of the complex was carried out in this study. The maximum wavelength was optimized to obtain the appropriate wavelength for the measurement of the iodine–starch complex. This experiment was conducted by scanning the solution in a visible range (400–800 nm).

The type and concentration of acid was optimized to obtain the appropriate acidic condition in the formation of the iodine–starch complex. This experiment was conducted by varying the acid type and the concentrations of HNO₃, H₂SO₄, and HCl from 0.5 to 1 M. The stability time of the complex was optimized to determine the precise time for measuring the solution.

After optimizing the measurement conditions, table salt samples were analyzed under the abovementioned conditions. Table salt samples used in this study were commercial table salt sold in Malang city.

RESULTS AND DISCUSSION

The principle of the spectrophotometric method for measuring the iodate content in salt is based on the reaction between iodate and iodide in an acidic condition to form iodine. Iodine reacts with starch solution to form the blue iodine–starch complex. The principle of the reaction is shown in (1).



Optimization of Chemical Parameters

Measurement at the maximum wavelength has high accuracy and reduces measurement errors. The absorbance of the iodine–starch complex increased with the increase in scanning wavelength. However, after passing through the maximum wavelength, the absorbance decreased, as shown in Figure 1. The optimum wavelength was chosen as 611 nm.

Iodide is a reducing agent, and the concentration of iodide affects the reduction process of iodate into iodine. Iodine reacts with starch solution to form the blue iodine–starch complex. The optimum concentration of iodide was 22.85×10^{-4} M.

Reduction process is affected by the acidity of the solution. The reduction of iodate into iodine requires high acidity. Three types of acids were used in this experiment, including HNO₃, H₂SO₄, and HCl. The concentrations of these three types of acid were varied from 0.5 to 1 M. The absorbance obtained using H₂SO₄ was found to be higher than that obtained using HNO₃ and HCl. The concentration of H₂SO₄ reached the optimum condition at 1 M. These results are illustrated in Figures 2 and 3.

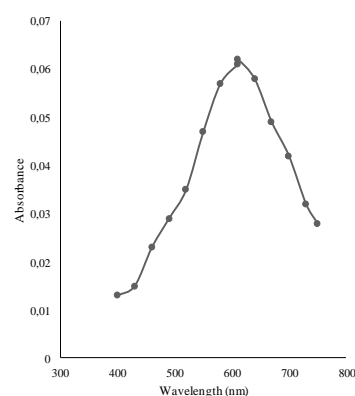


Figure 1. Determination of the maximum wavelength.

Starch or amyllum is complexed with iodine, which is produced from the reduction of iodate by iodide under acidic conditions. Starch concentrations were varied from 0.5% to 2.5% to assess the availability of the optimum starch amount required for producing the iodine–starch complex. Results of this experiment (Figure 4) showed that the absorbance of the complex increased with increasing starch concentrations. The optimum concentration was chosen as 1% of starch solution.

The stability time of the complex was optimized to determine the precise time for measuring the solution. The optimum stability time of the complex was 8 min.

Linearity of Measurement

Under the optimum conditions described above (i.e., maximum wavelength of 611 nm, optimum iodide concentration of 22.85×10^{-4} M, 1 M H_2SO_4 , 1% starch, and 8 min of stability time of the complex), the measurement method was found to be linear ($y = 0.0065x + 0.4426$, $R^2 = 0.9901$) (Figure 6).

Sample Analysis

A total of six commercial table salt samples sold in Malang city were analyzed in this study. The measurement results are presented in Table 1, which shows that samples A, B, and C had iodine concentrations more than 30 ppm, which are consistent with SNI 3556:2010, whereas samples D, E, and F contained low iodine concentrations.

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