МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ МЕДИЧНИЙ УНІВЕРСИТЕТ

# GASTRIC JUICE ACIDITY DETERMINATION AND TAP WATER HARDNESS DETERMINATION

Methodical instructions for 1st year students' self-work
in Medical Chemistry

# ВИЗНАЧЕННЯ КИСЛОТНОСТІ ШЛУНКОВОГО СОКУ ТА ЖОРСТКОСТІ ВОДОПРОВІДНОЇ ВОДИ

Методичні вказівки для самостійної роботи студентів 1-го курсу
з медичної хімії

Затверджено
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Визначення кислотності шлункового соку та жорсткості водопровідної води: метод. вказ. для самостійної роботи студентів 1-го курсу з мед. хімії /уклад. Г.О. Сирова, С.М. Козуб, В.О. Макаров та ін. − Харків: ХНМУ, 2017.− 16 с.

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**Subject «Gastric juice acidity determination and Tap water hardness determination»**

1. **Number of hours** 4
2. **Material and methodological support.**

Posters:

1. Graph structure of the subject.
2. Titration curves
3. Most common acid-base indicators
4. Laboratory glassware used in titrimetric analysis
5. Operation technique with pipettes
6. Instructions for use of glassware

Laboratory glassware and reagents for performing of laboratory works: «Gastric juice aicidity determination», «Tap water hardness determination» (stand rods, burettes, solutions of NaOH, $H_2C_2O_4{\cdot}2H_2O$, solution of gastric juice with different acidity, B Trilon solution, ammonia buffer, indicators: methyl orange, phenolphtalein, chromogen black).

Education literature

1. Medical chemistry / V.A. Kalibabchuk, V.I. Halynska, V.I. Hryshchenko et al.; – Kyiv:AUS Medicine Publishing, 2010, - 224 p.
2. Fundamentals of medical chemistry: manual for students' self-work / A.O. Syrovaya, E.R. Grabovetskaya, L.G. Shapoval. – Kharkiv: KhNMU, 2015.–196 p.
3. Medical chemistry. Adapted concise course: manual for students' self-work / A.O. Syrovaya, E.R. Grabovetskaya, L.G. Shapoval. - Kharkiv: KhNMU, 2013. – 160 p.
4. Medical chemistry: workbook for self-work of first-year students of medical and dentistry faculties / compiled by A. O. Syrovaya, V. N. Petunina, V. A. Makarov et al. – Kharkiv : KhNMU, 2017. – 72 p.
5. Gastric juice acidity determination and Tap water hardness determination: methodical instructions for 1st year students' self-work in Medical Chemistry / compiled by A.O. Syrovaya, S.N. Kozub, V.O. Makarov et al. – Kharkiv: KhNMU, 2017. – 16 p.
6. Individual tasks for students' self-control of knowledge in Medical Chemistry / A.O. Syrovaya, L.G. Shapoval, V.N. Petiunina, et al. – Kharkiv: KhNMU, 2014. –50 p.
7. Text of lecture.

3. **Substantiation for the subject.** Methods of titrimetric analysis are widely used in medico-biological and hygienic investigations to make the analysis of biological liquids, drinking water and sewage, food, medicines, etc. Knowledge in titrimetric analysis is necessary for a future doctor to solve a large number of scientific and practical questions.

4. **The purpose of the subject:**

- general: to analyze principles of titrimetric methods of analysis
- specific: to analyze quantitative content of substance in the solutions using methods of acid-base titration.

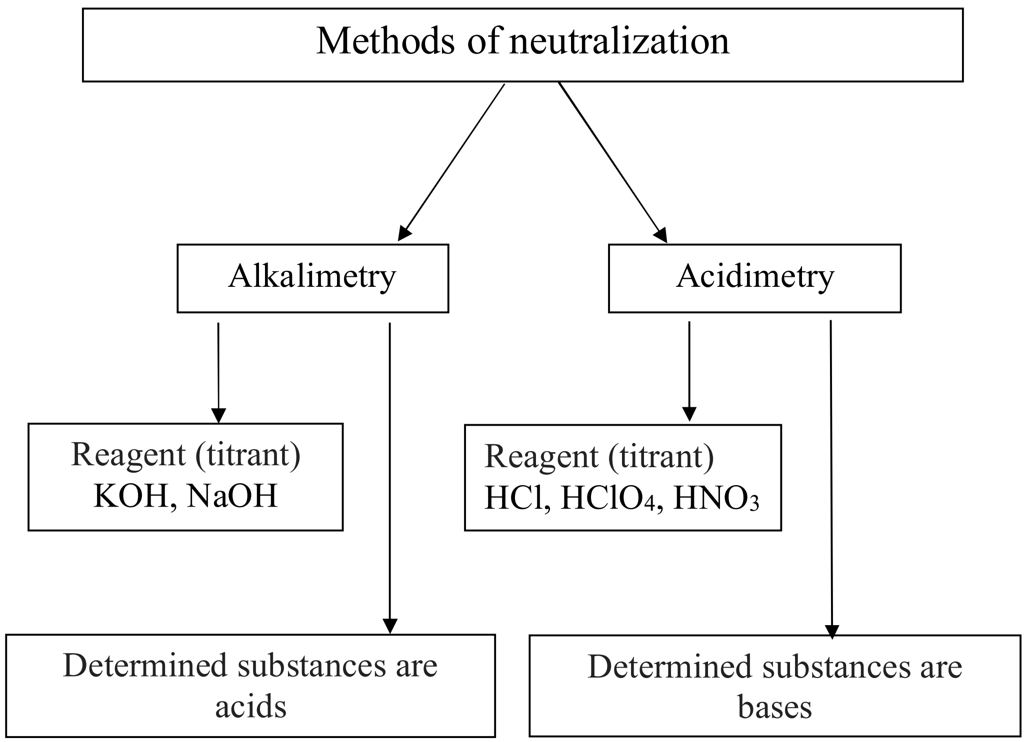
a) **to know:** titration technique and the determination of the equivalence point, volumetric glassware used for analysis.

b) **to be able to:** calculate the molar concentration of the equivalent and titer of the investigated solution according to the results of titration, determine the purity of the medicine i.e. the mass percent of active substance in the initial mass or in the solution according to the results of titration.

c) **practical skills:**

- to determine the molar mass of the equivalents;
- to calculate mass of the substance necessary to prepare a definite volume of operating solution with the given molar concentration of the equivalent;
- to calculate the molar concentration of the equivalent and titer of the investigated solution according to the results of titration;
- to determine the purity of the medicine i.e. the mass percent of active substance in the initial mass or in the solution according to the results of titration.

5. **Graph structure of the subject.**



## 6. Plan of students' work.

| No | Stage | Time, min | Training and visual aids | Location |
|---|---|---|---|---|
| 1. | Motivational characteristics and plan of the subject. Answers to the students' questions | 15 | Text-book (work-book) | Class room |
| 2. | Incoming control | 20 | | |
| 3. | Discussion of procedure of laboratory work № 1 | 10 | | |
| 4. | Performing of laboratory work and recording | 35 | Operating solution of NaOH, investigated solution of gastric juice | |
| 5. | Defence of laboratory work | 10 | | |
| 6. | Discussion of procedure of laboratory work № 2 | 10 | | |
| 7. | Performing of laboratory work and recording | 35 | Operating solution of B Trilon, ammonia water, tap water | |
| 8. | Defence of laboratory work | 10 | | |
| 9. | Final control | 25 | Tests | |
| 10. | Analysis, summing up the lessons. Home-work | 10 | | |

7. **Tasks for self-work:**

**- list of questions to be studied:**

1. Gastric juice.
2. Tap water.

## 1. Gastric juice.

Pure gastric juice is a colorless liquid with pieces of mucus. It contains hydrochloric acid, enzymes, mineral substances, gastric secretin, mucus, residues of organic compounds.

In clinical practice the acidity of gastric juice is expressed in titrimetric (clinical) units: the quantity of 0.1M NaOH solution in mL which is required for neutralization of 100 ml of gastric juice.

The content of free hydrochloric acid and the total acidity of gastric juice are determined during the clinical analysis.

The range of a standard **total acidity** of gastric juice is 40—60 mmol/L (t.u.) and for the content of free hydrochloric acid (**actual acidity**) is 20—40 mmol/L (t.u.). If the result exceeds the normal value it is called a **hyper acidity**. Such phenomena is observed at the peptic ulcer, hyperpeptic gastritis and at a number of nervous disorders.

- list of practical skills to be mastered.

After studying the subject you must be able to determine the molar mass of the equivalents; write down the law of equivalents for every couple of interacting substances; calculate mass of the substance necessary to prepare a definite volume of operating solution with the given molar concentration of the equivalent; calculate the molar concentration of the equivalent according to the mass of the substance taken in the definite volume; to calculate the molar concentration of the equivalent and the titer of the investigated solution according to the results of titration; to determine the purity of the medicine i.e. the mass percent of active substance in the initial mass or in the solution according to the results of titration.

## 2. Tap water.

Hardness is one of the technological parameter taken to characterize content and quality of natural waters. Water is called hard if it has high concentration of $Ca^{2+}$ and $Mg^{2+}$ ions. There are two types of hardness: temporary – caused by the presence of hydrocarbonates $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$; noncarbonate – caused by the presence of sulphates and chlorides of $Ca^{2+}$ and $Mg^{2+}$ in water.

The complexometric method of analysis is used to determine hardness of water. It is based on the titration of water at the presence of ammonium buffer and indicator with trilon B till the colour change from red to blue. The complex of metal ion with the trilon B solution forms during the titration.

The complex of metal ion with the indicator is broken down in the process of titration, a new complex with trilon B is formed and the indicator is segregated in a free state. The indicator in the free state and the indicator combined with the metal ion are colored differently:

$$\underbrace{Me^{2+}+H_2Ind}_{\text{blue}} \leftrightarrow \underbrace{MeInd+2H^+}_{\text{red}}; \qquad \underbrace{MeInd}_{\text{red}}+\text{Trilon B} \leftrightarrow \text{Me-B Trilon}+\underbrace{H_2Ind}_{\text{blue}}$$

| The value of total hardness | Type of water |
|---|---|
| till 2 | soft |
| from 2 till 6 | moderate hardness |
| from 6 till 10 | hard |
| more than 10 | very hard |

## ALGORITHM OF THE LABORATORY WORK № 1.
## GASTRIC JUICE ACIDITY DETERMINATION

### Summary of the method.

Acid content in physiological liquids influences the cell activity, organs and entire organism. Determination of acidity of gastric juice, blood, urine belongs to the series of analysis which are performed to diagnosis of diseases and monitor the treatment.

Pure gastric juice is a colorless liquid with pieces of mucus. It contains hydrochloric acid, enzymes, mineral substances, gastric secretin, mucus, residues of organic compounds.

In clinical practice the acidity of gastric juice is expressed in titrimetric (clinical) units: the quantity of 0.1M NaOH solution in mL which is required for neutralization of 100 mL of gastric juice.

The content of free hydrochloric acid and the total acidity of gastric juice are determined during the clinical analysis.

The range of a standard **total acidity** of gastric juice is 40—60 mmol/L (t.u.) and for the content of free hydrochloric acid (**actual acidity**) is 20—40 mmol/L (t.u.). If the result exceeds the normal value it is called a **hyper acidity**. Such phenomena is observed at the peptic ulcer, hyperpeptic gastritis and at a number of nervous disorders.

If the result is less than a normal value it is called a **hypo acidity**. Hypoacidity is observed at the acute infectious diseases, hyperpeptic gastritis, gastric cancer etc.

### Experimental procedure.

1) Pipette exact volume (5 mL) of the investigated solution of gastric juice (aliquot);

2) Transfer this aliquot into the titration flask and add 2 – 3 drops of phenolphthalein and methyl orange. Then add two drops of the indicators: methyl orange and phenolphthalein;

3) Fill the burette with NaOH solution and perform titration. Titrate against NaOH until colour changes from red to orange coloration. Stop the titration and reading of the burette which represents the end point ($V_1$). Write down result in the table below. The volume of NaOH solution used for the titration ($V_1$) should be noted down then. Continue the titration of this sample up to the color change through yellow to crimson and then note down the volume of NaOH solution volume used for the titration ($V_2$). Fill the table.

4) The titration process should be carried out till three coincided results will be obtained.

| № | Results of titration V (g.j.) = 5 mL | | *The results of the calculation* |
|---|---|---|---|
| | $V_1$ (NaOH), mL | $V_2$ (NaOH), mL | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| $V_{1av.}$ = | | $V_{2av.}$ = | |

The experimental data processing:

1) Calculation of the correction factor:

$$K = \frac{0.1}{C(NaOH)}$$

2) Calculation of active acidity of gastric juice:

$$HCl_{free} = \frac{V_{1av}(NaOH)\cdot 100}{V_{g.j.}\cdot K} \text{, units}$$

3) Calculation of total acidity of gastric juice:

$$\text{The total acidity} = \frac{V_{2av}(NaOH)\cdot 100}{V_{g.j.}\cdot K} \text{, units}$$

**Conclusions**.

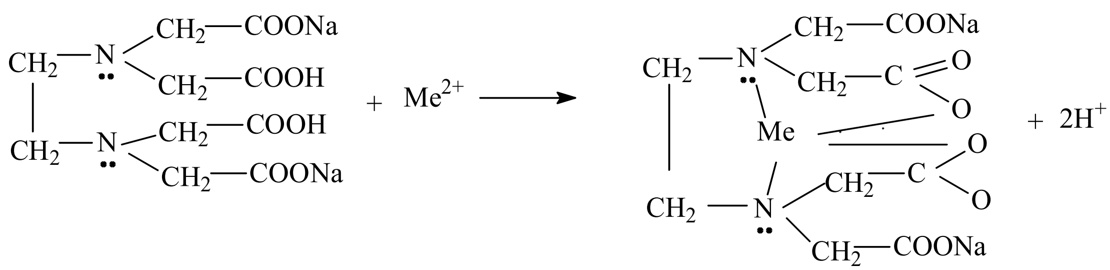
**ALGORITHM OF THE LABORATORY WORK № 2.**

**Laboratory work «HARDNESS WATER DETERMINATION»**

**Summary of the method.**

Hardness is one of the technological parameter taken to characterize content and quality of natural waters. Water is called hard if it has high concentration of $Ca^{2+}$ and $Mg^{2+}$ ions. There are two types of hardness: temporary – caused by the presence of hydrocarbonates $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$; noncarbonate – caused by the presence of sulphates and chlorides of $Ca^{2+}$ and $Mg^{2+}$ in water.

The complexometric method of analysis is used to determine hardness of water. It is based on the titration of water at the presence of ammonium buffer and indicator with trilon B till the colour change from red to blue. The complex of metal ion with the trilon B solution forms during the titration:



The complex of metal ion with the indicator is broken down in the process of titration, a new complex with trilon B is formed and the indicator is segregated in a free state. The indicator in the free state and the indicator combined with the metal ion are colored differently:

$Me^{2+} + H_2Ind \leftrightarrow MeInd + 2H^+$ ;    $MeInd + \text{Trilon B} \leftrightarrow \text{Me-B Trilon} + H_2Ind$

blue    red    red    blue

| The value of total hardness | Type of water |
|---|---|
| till 2 | soft |
| from 2 till 6 | moderate hardness |
| from 6 till 10 | hard |
| more than 10 | very hard |

**Experimental procedure.**

1) Pipette exact volume (5 mL) of tap water and transfer into the titration flask;
2) Add 2.5 mL of ammonium buffer and 2 drops of indicator (chromogen black);
3) Fill the burette with trilon B and start titration. Titrate the water against trilon B solution until the coloration changes from red to blue;
4) The titration process should last until tree coincided results (values) are obtained;
5) Measure the volume of trilon B required for titration, and note down the data into the table:

| № | $V(H_2O)$, mL | V(trilon B), mL | The results of the calculation |
|---|---|---|---|
| 1. | V = 5.0 | $V_1$ = | |
| 2. | V = 5.0 | $V_2$ = | |
| 3. | V = 5.0 | $V_3$ = | |
| $V_{av.}$ = | | | |

The experimental data processing:

1) Calculate the molar concentration of equivalent of standard solution of trilon B, if $M(Na_2H_2Y)$ = ______ and there are *m* = _____ g in *V* =_ ____ mL of solution:

$$C(1/2Na_2H_2Y) = \frac{m(Na_2H_2Y)}{M(1/2Na_2H_2Y) \times V(Na_2H_2Y)}$$

2) Calculate total hardness of water:

$$H(H_2O) = \frac{C(1/2Na_2H_2Y)mol/L \times V_{av}(Na_2H_2Y)ml}{V(H_2O)ml} \times 1000$$

Conclusions.

8. **Tasks for knowledge control.**

1. What acid is part of gastric juice?
A) $H_2C_2O_{4,}\times 2\ H_2O$;
B) HCl;
C) $H_2SO_4$;
D) $H_3PO_4$.

2. In which units express acidity of gastric juice in clinical practice?
A) grams;
B) mol/L;
C) grams/ml;
D) titrimetric units.

3. The range of a standard actual acidity of gastric juice is:
A) 20 – 40;
B) 40 – 60;
C) 60 – 80;
D) 80 – 100.

4. Which ions determine the hardness of water?
A) iodine and bromine
B) calcium and magnesium;
C) silver and mercury.

5. What indicator should be used for determine the hardness of water?
A) methyl orange;
B) chromogen black;
C) phenolphthalein;
G) no one.

Answers: 1 - B; 2 - D; 3 - A; 4 – B; 5 - B.

## 9. **Recommendations for the work results design**

Algorithms for solving educational problems of class work and self-work, and conclusions of laboratory work should be recorded in the workbook.

## 10. **Suggested readings**

1. Inorganic Chemistry: manual / V.O. Kalibabchuk, V.V. Ogurtsov, V.B.Emelianov, V.I.Galinska et all. - Kiev: BCB "Medicine", 2017. - 300 p.

**Навчальне видання**

# Визначення кислотності шлункового соку та жорсткості водопровідної води

**Методичні вказівки для самостійної роботи студентів 1-го курсу з дисципліни «Медична хімія»**

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