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"DETERMINATION OF ALUMINIUM AND MAGNESIUM IONS IN SOME COMMERCIAL ADSORPTIVE ANTACIDS BY COMPLEXOMETRIC TITRATIONS"

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Abstract:

The study is presented here for titrimetric analysis of consumer products-antacids, which involves active ingredients Aluminum and Magnesium ions. It is an experiment, involving determination of Aluminum and Magnesium ions, which enables the student to gain knowledge about complexometric direct and back titrations containing the concepts and usages of masking, buffer controls and metallic indicators. The commercial antacids which are analyzed include such as Tablets- Digene, Gelucil MPS, Alcid and Suspensions- Gelucil MPS, Gascidity, Digusil MPS. As tablets contain silicates therefore silica determination is also possible by gravimetry. The setting of procedure is done by analyzing standard solution of Aluminum and Magnesium and there synthetic mixtures.

Key words: *ingredients of Aland Mg ions, silica, Alcid, Gascidity, Digusil.*

Introduction:

The teaching of titrimetric analysis has now introduced purposeful exercise involving analysis of consumer products such as antacids. S.P.Yang and R.Y.Tsai have recently mentioned complexometric estimation of some adsorptive antacids. Based on this article an experiment is designed for the determination of aluminum and magnesium ions in antacids available in Indian market. Antacids- antacids are useful to relive acid indigestion upset and sour stomach or heartburn. Antacids are the substance, which neutralize or counteracts acidity. Antacids are widely divided into two classes: Chemical antacids & Adsorptive antacids.

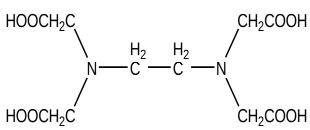
Chemical antacids work by chemical neutralization of gastric acid. e.g. Sodium Bicarbonate. A chemical antacid shows most rapid action but May cause "acid rebound" a condition in which the gastric acid returns in greater concentration after the drug effect has stopped .Adsorptive antacid works by adsorbing the acid. eg. These are present in following forms:
Al & Mg with identical form in an antacid eg. Al $(OH)_3$ & $Mg(OH)_2$
Al & Mg with different form in an antacid eg. 1) $Al(OH)_3$ & MgO 2) Al_2O_3 & $Mg(OH)_2$
Al & Mg with identical form and constituent of the same compound eg. $Al(OH)_3$, $Mg(OH)_2$ & $MgAl_2(SiO_4)2H_2O$.

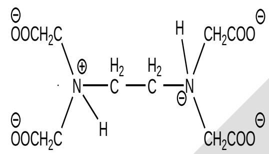
Adsorptive antacids are less prone to rebound effect. Antacids with aluminium ion used as the active ingredient in the form of alumina, aluminium hydroxide and basic aluminium carbonate. Antacids with magnesium ion usually contain magnesia and magnesium trisilicate, magnesium carbonate, magnesium hydroxide.

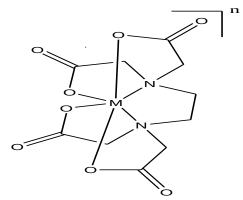
Complexometric titration: Complexometric reactions may have uses in analytical chemistry but their classical application is in complexometric titrations. Here metal ion reacts with suitable ligand to form a complex and endpoint and it is determined by an indicator or by an appropriate instrumental method. Most simple inorganic ligands are unidentate which can lead to low complex stability and indistinct end point. As titrants, Multidentade ligands, particularly those having 4 or 6 donor groups have two advantages over their unidentate counterparts. First, they generally react more completely with cations and thus provide sharper end points. Secondly, they ordinarily react with metal ions in a single step process, whereas complex formation with unidentade ligands usually involving two or more intermediate species.

EDTA as Titrant: Ethylene diamine tetra acetic acid also called ethylene dinitrito tetra acetic acid, Trillion-B, Complexone-III and chelation-B.

EDTA has structural formula: Zwitter ion form of EDTA: Structure of metal ion EDTA complex:







M=Al3+/MG2+/Zn2+ n=-1/-2/-2

In most of complexometric titrations EDTA is used as a titrants because -Its relatively low prices and it acts as a hexadentate ligand. EDTA is a species which behaves like an amino acid when dissolved in water. The various forms of EDTA are often abbreviated as H_4Y, H_3Y^-, H_2Y^{2-}, HY^{3-}, Y^{4-}. Relative amounts of this species varies as function of pH.

$$Na_2H_2Y \xrightarrow{pH5} H_2Y^{2-} + 2H^+ + 2Na^+$$

$$Na_2H_2Y \xrightarrow{pH10} HY^{3-} + 3H^+ + 2Na^+$$

Fully protonated form, H4Y is only major component in very acidic solutions (pH<3). Through ought the pH to range of 3-10 the species H2Y2- and HY3- are predominant. The fully unprotonated form Y4- is significant component only in very basic solutions (pH>10).There are four types of EDTA Titrations as follows: Direct titration, Back titration, Replacement titration, Alkali metric titration. Here in present experiment involves Direct titration and Back titration.

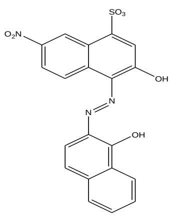
Direct titration: Direct titration procedure with a metal ion indicator used when response of indicator to metal ion is easiest and most convenient to use. The end point may also be determined by Amperometry, Conductometry and Spectrophotometry.

Back titration: Many metals cannot for various reasons be titrated directly; thus they may precipitated form the solution in the pH range necessary for the titration or they may form complexes too slowly or a suitable metal indicator is not available i.e. they may block indicator. In this method excess of standard EDTA solution is added, the resulting solution is buffered to a desired pH and excess of reagent is back titrated with standard metal ion solution and end point is detected by suitable indicator.

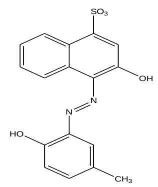
Metallochromic indicators: The success of an EDTA titration depends upon the precise determination of the end points. The requisites of metal ion indicators for use in the visual detection of end points include: The colour reaction should be specific of at least selective. The metal-indicator complex should possess sufficient stability. But the metal-indicator complex should be less stable than metal EDTA complex. The colour contrast between the free indicator and metal-indicator complex should be such as to be readily observed. The indicator must be very sensitive to metal ions so that colour changes occur as near to the equivalence point as possible. The above requirements must be fulfilled within the pH range at which the titration is performed. The indicators which are used in this experiment are: Eriochrome black-T, Calmagite, Xylenol orange.

Structure of the indicators:

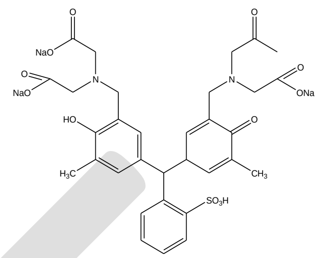
Eriochrome black-T



Calmagite



Xylenol orange: Tetra sodium salt of xylenol orange



Yellow ---→ Slight Red.

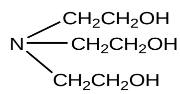
Eriochrome black-T is generally represented as: H_2In^-

$$\underset{\text{(Red)}}{H_2In^-} \xrightarrow{\text{pH5.3-7.3}} \underset{\text{(Blue)}}{HIn^{2-}} \xrightarrow{\text{pH10.5-12.5}} \underset{\text{(Orange)}}{In^{3-}}$$

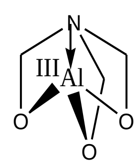
Buffers: Generally pH of solution changes on addition of small amount of acids or based to it. But if the solution contains weak acid and its conjugated base or a weak base and its conjugate acids such solution can resist changes in pH and is called buffer solution. The ability of buffer solution to resist changes in pH on addition of small amount of acids or bases is called buffer action. Depending upon pH values buffers solutions are divided into two classes. If the pH of solution is less than 7 it is called as acidic buffer. eg. Acetate-acetic used as acidic buffer solution. If the pH is more than 7 it is called basic buffer eg. Bicarbonate-carbonate used as basic buffer solution.

Masking agents: EDTA is very unselective reagent because it complexes with numerous di-, tri- and tetra-valent cations, so masking is one of the method helps to increase the selectivity. Masking may be defined as the process in which a substance, without physical separation of it or its reaction products, is so transformed that it does enter into a particular reaction. Damasking is the process in which masked substance regains its ability to enter into a particular reaction.

e.g. Tri ethanol amine



Al-TEA complex



Information about the antacids used for analysis:

Assay:

Brand name (Tablet)	Manufacturer	Average weight of Tablet(gm)	Each uncoated chewable tablet contains		Simethicone = S Activated Dimethicone = AD
			Aluminium	Magnesium	
Dignen	Briocia Pharma (i) Pvt.ltd. E-1,MIDC.Jejuri-412303	1.208	113.4mg = 4.203 mmoles	147.4mg= 0.606 mmoles	S = 25mg
Gelucil-MPS	Pfizer Ltd. Shirgaon, Kolhapur-416234.	1.116	96.1mg = 3.561 mmoles	108.5mg= 4.464 mmoles	AD = 50mg
Alcid	Alkem Laboratories Ltd.B.No-AIT-50641	1.201	113.4mg = 4.203 mmoles	147.4mg= 0.606 mmoles	S = 25mg

*coloured components= Erythrosine & Ponceau4R, *colour=Pink, *Al=$Al(OH)_3$ & $MgAl(SiO_4)_2.H_2O$, *Mg=$Mg(OH)_2$ & $MgAl_2(SiO_4)2.H_2O$.

Table-2

Brand name (Suspension)	Manufacturer	Each teaspoon (5ml) contains		Sorbitol solution (70%) IP (gm)
		Aluminium	Magnesium	
Gelucil-MPS	Pfizer Ltd. Shirgaon,Kolhapur-416234.	86.49mg= 3.205 mmoles	104.2mg= 4.279 mmoles	1.25
Gascidity	ESPI Industries & Chemical Pvt. Ltd. Hydrabad-500039.	86.49mg= 3.205 mmoles	104.2mg= 4.279 mmoles	0.65
Digucil-MPS	Cipla Ltd. Mumbai Central Mumbai-400008.	86.49mg= 3.205 mmoles	104.2mg= 4.279 mmoles	1.25

* 5ml suspension= 50mg of Activated dimethicone, *coloured component=Erythrosine, *Colour=Pink, *Al = $Al(OH)_3$, *Mg = $Mg(OH)_2$

Useful information:

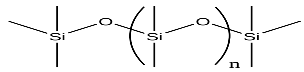
- In the tablet- Al is in form of $Al(OH)_3$ & $MgAl_2(SiO_4)H_2O$
  Mg is in the form of $Mg(OH)_2$ & $MgAl_2(SiO_4)H_2O$
- In the suspension-Al is in form of $Al(OH)_3$ only.
  Mg is in the form of $Mg(OH)_2$ only.

Roll of ingredients-

$MgAl_2(SiO_4)H_2O$:- magnesium aluminium silicate hydrate binds surplus gastric acid & quickly eliminates pain, heartburn & other discomforts that accompany excessive secretion of gastric acid.

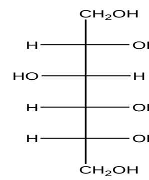
Simethicone:- It is an oral antifoaming agent. Used to reduce bloating, discomfort & pain caused by excess gas in the stomach or internal tract. It is mixture of polydimethyl siloxane & silica gel (silicon diioide)

Dimeticone:- It is most widely used silicon based organic polymer & it is particularly known its rheological properties.



Chemical formula= $[(CH_3)_2OSi]_n$: It is common additive to antacids.

Sorbitol:- it is also known as glucitol, is a sugar alcohol the body metabolises, it is obtained by reduction of glucose. It is mostly used as sweetener. IUPAC name of sorbitol is Hexane1, 2, 3, 4, 5, 6 hexanol.



Aluminium hydroxide or Al $(OH)_3$:-

Pharmacologically this compound is also known as Alu-cap or Aludrox, is used as an antacid. The hydroxide reacts with excess of acid. In the stomach, reducing its acidity of the content of the stomach may in turn help to relive the symptoms of ulcers heartburn.

$Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$

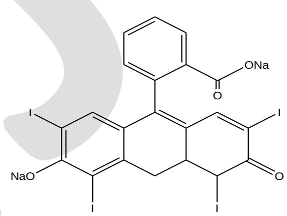
Magnesium hydroxide or $Mg(OH)_2$:-

It also known as milk of magnesia & is commonly used as an antacid to remove stomach acid.

$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

Ponceau 4R:- It's a synthetic coal tar & red azo dye which can be used in variety of food products. Ponceau 4R is also known as food red 7, C.I., 16255E Number-E214.

Erythrosine:- It is a cherry ponk coal based fluorine dye. E. number-E127.



λmax=530nm

Masses of Al^{3+}, Mg^{2+}, SiO_2 in Tablets/Suspension:-

Gelucil MPS:

$Mg(OH)_2$:- by manufacturer:

$Mg(OH)_2 \approx 1Mg$

58.305 = 24.305

250mg = ?

= 104.20mg of Mg.

By stoichiometry: $\frac{250mg\ Mg(OH)_2}{58.305 \times 10^3 mg} \times \frac{1Mole\ Mg}{1Mole\ Mg(OH)_2} \times \frac{24.305 \times 10^3 mg\ of\ Mg}{Mole\ of\ Mg}$

=104.21 mg of Mg

$MgAl_2(SiO_4)_2H_2O$: by manufacturer:

$MgAl_2(SiO_4)2H_2O \approx 1Mg$

280.985 = 24.305gm Mg

50mg = ?

=4.325 mg of Mg.

By stoichiometry: $= \frac{50}{280.985 \times 10^3 mg\ of\ MgAl_2(SiO_4)2H_2O} \times \frac{1Mole\ Mg}{1Mole\ MgAl_2(SiO_4)2H_2O} \times \frac{24.305 \times 10^3 mg\ of\ Mg}{Mole\ of\ Mg}$

=4.324 mg of Mg

$Al(OH)_3$: by manufacturer:

$Al(OH)_3 \approx 1Al$

77.98gm = 26.98gm

250mg = ?

= 86.49 mg of Al.

By stoichiometry: $= \frac{250}{77.98 \times 10^3 mg\ of\ Al(OH)_3} \times \frac{1Mole\ Al}{1Mole\ MgAl(OH)_3} \times \frac{26.98 \times 10^3 mg\ of\ Mg}{Mole\ of\ Al}$

= 86.49 mg of Al.

\\$MgAl_2(SiO_4)2H_2O$: by manufacturer:

$MgAl_2(SiO_4)2H_2O \approx 2Al$

280.985 = 53.96gm Al

50mg = ?

= 9.601 mg of Al.

By stoichiometry: = $\frac{50}{280.985 \times 10^3 \text{mg of } MgAl_2(SiO_4)2H_2O} \times \frac{2\text{Mole Al}}{1\text{Mole } MgAl_2(SiO_4)2H_2O} \times \frac{26.98 \times 10^3 \text{mg of Al}}{\text{Mole of Al}}$

=9.601 mg of Al

$MgAl_2(SiO_4)2H_2O$: by manufacturer:

$MgAl_2(SiO_4)2H_2O \approx (SiO_4)_2$

280.985 = 184.172gm Mg

50mg = ?

= 32.77 mg of Mg.

By stoichiometry: = $\frac{50}{280.985 \times 10^3 \text{mg of 1Mole } MgAl_2(SiO_4)2H_2O} \times \frac{2\text{Mole } SiO_4}{MgAl_2(SiO_4)2H_2O} \times \frac{92.086 \times 10^3 \text{mg of } SiO_4}{\text{Mole of } SiO_4}$

= 32.77 mg of SiO_4

Brand name	Salt of Al/Mg	Mass of elemental Al/Mg in mg.	
		By manufacturer	By Stoichiometry
Gelucil MPS(Tab)	$Al(OH)_3$	86.49	86.49
	$Mg(OH)_2$	104.20	104.21
	Mg$Al_2(SiO_4)2\ H_2O$	4.325	4.324
	Mg**Al_2**$(SiO_4)2\ H_2O$	9.601	9.601
	$MgAl_2$**$(SiO_4)2$** H_2O	32.77	32.77
Digene/Alcid (Tab)	$Al(OH)_3$	103.790	103.795
	$Mg(OH)_2$	10.421	10.421
	Mg$Al_2(SiO_4)2\ H_2O$	4.325	4.324
	Mg**Al_2**$(SiO_4)2\ H_2O$	9.601	9.601
	$MgAl_2$**$(SiO_4)2$** H_2O	32.77	32.77
Gelucil MPS/ Gascidity/ Digucil MPS (Suspension)	$Al(OH)_3$	86.49	86.49
	$Mg(OH)_2$	104.20	104.21

Overview of the method used: First the antacid sample distinguished using acid mixture ($HCl+HNO_3$) then resulted solution is diluted to known volume. The metal ion from this solution is determined by complexometric direct and back titration and silica oxide is determined by gravimetry.

Reactions:

$$\text{Salts of Al \& Mg} \xrightarrow{H^+} Al^{3+} + Mg^{2+}$$

$$\text{Organic Matter} \xrightarrow{H^+} \text{Volatile Products}$$

Method A- Determination of both (Al^{3+} +Mg^{2+}) from mixture:

Aliquote(10ml)

↓ **1.pH=10**
2.known excess EDTA
3.Heat= Al-EDTA
4.Cool
5.EBT-indicator

Titration with Zn^{2+}

↓

Zn-In complex(purpal)

↓

amount of Al^{3+}& Mg^{2+}
gets determined

Blank titration: used same procedure instead of taking aliquot.

Reactions:

$$Al^{3+} + Mg^{2+} + HY^{3-}\text{(excess)} \longrightarrow AlY^{-} + MgY^{2-} + HY^{3-}\text{(unused)}$$

$$\text{Burette} \longrightarrow Zn^{2+}$$

$$\text{flask} \longrightarrow AlY^{-} + MgY^{2-} + HY^{3-}\text{(unused)} + HIn^{2-}\text{(blue)}$$

$$\text{After titration} \longrightarrow \text{ZnIn(purple)}$$

Method B: Determination of Al^{3+} from mixture

Aliquote(10ml)

↓ **1.pH=5**
2.known excess EDTA
3.Heat
4.Cool
5.xylenol orange

Titration with Zn^{2+}

↓

Zn-xylenol complex(orange)

↓

amount of Al^{3+}
gets determined

Reactions:

$Al^{3+} + Mg^{2+} + HY^{3-}(excess) \longrightarrow AlY^{-} + MgY^{2-} + HY^{3-}(unused)$

Burette $\longrightarrow$ Zn^{2+}

flask $\longrightarrow$ $AlY^{-} + H2Y^{2-}(unused) + $ xylenol orange(yellow)

After titration $\longrightarrow$ Zn-xylenol orange (slight red)

Method C: Determination of only Mg^{2+} from mixture

Aliquote(10ml)

↓
- **1.pH=10**
- **2.TEA-->(Al-TEA)**
- **3.EBT-->$MgIn^{-}$(wine red)**
- **4.Cool**
- **5.xylenol orange**

Direct Titration with EDTA

↓

Free HIn^{2-}(blue)

↓

amount of Mg^{2+} gets determined

Blank titration: used same procedure instead of taking aliquot.

Reactions:

$Al^{3+} + Mg^{2+} + HIn^{2-}(blue) \longrightarrow MgIn^{-}$(wine red $+ H^{+} +$ Al-TEA(masked)

Burette $\longrightarrow$ EDTA(HY^{3-})

flask $\longrightarrow$ Al-TEA + $MgIn^{-}$(wine red

After titration $\longrightarrow$ $MgY^{-} + HIn^{2-}$(blue)

Experimental work:

Reagent preparation: EDTA standard solution (0.01M); Standardize Zn^{2+} solution (0.01M); Acetate-Acetic buffer solution; Bicarbonate-Carbonate buffer solution; Xylenol Orange indicator; Eriochrome Black-T indicator

Analysis of Samples:

Individual metal ions: solution of Al^{3+} is prepared by dissolving known quantity of Al^{3+} foil in hydrochloric acid and then diluted to known volume. Solution of Mg^{2+} is prepared by dissolving known quantity of magnesium sulphate heptahydrate in minimum amount of water and then diluted to known volume.These solutions are analysed by using procedure mentioned in article (1.3.2,d)

Synthetic mixture: after individual metal ion analysis synthetic mixture is prepared by taking known quantity of each solution, mixed them. Then diluted to known volume. This solution is analyzed by using procedure mentioned in article (1.3.2,d)

Antacid Disintegration: Take an antacid sample and record its brand name, active ingredient and declared quantity of each component. Weigh the tablet or precisely /measure the volume of suspension precisely. There is no need of grinding, as tablet simply gets dissolved in acid mixture. Transfer the Tablet/ suspension in 100ml Erlenmeyer flask. To it add 10 ml of $HCl+HNO_3$ in the proportion of (3:1). Heat it on open flame till disappearance of brown fumes. Cool the content adds 20ml of distilled water and again boil it. Remove the flask and allow it to cool and after cooling filter the mixture. Dilute the filtrate to calibration mark (250ml) with distilled water. Stopper the flask and mix the solution well by inverting and shaking it repeatedly, label this solution. Dry the residue in an oven and used for further analysis of silica.

Procedure used:

Method 1: Determination of total (Al^{3+} &Mg^{2+}) content:

Pipette out a 10ml aliquot of the sample solution into 125ml Erlenmeyer flask followed by adding about 15ml of bicarbonate-carbonate buffer solution (pH10) transfer quantitatively a 35.00ml of aliquot of standard EDTA solution to the flask using a burette (denoted V_{edta}). Boil gently the mixture for 5minutes on open flame to speed up the formation of Al-EDTA complex. Cool it under tap water. Add 5drops of Eriochrome Black-T indicator and mix it well. The solution should be pure blue in colour if the EDTA is not enough to chelate all of the metallic ions completely the solution should be wine red in colour, at this wine red solution. Boil again until colour changes to purpul blue. Back titrate the solution with standardized the Zinc solution until colour changes to purpule at the end point. Record the volume (as V_{zn}). Repeat the titration twice and perform the blank titration using same procedure instead of taking aliquot. Calculate the total mill moles of Aluminium and Magnesium ions in the sample.

Method 2- Determination of only Al3+ content:

Pipette a 10ml aliquot of the sample solution to 125ml Erlenmeyer flask add 15ml of acetate-acetic acid buffer solution (pH5) to mask the formation of Mg-EDTA complex. Transfer exact 25ml of aliquot of standard EDTA solution to the flask using burette.(denoted by V_{EDTA}). Boil it gently on open flame for 5minutes to speed up the formation of Al-EDTA complex. Cool the content under running water and then add 5drops of Xylenol orange indicator and mix well. The solution should appear lemon yellow in colour at this moment. If the EDTA is not enough to chelate Aluminium ion, the solution should be deep red in colour. In this case put an additional 5ml or more aliquot of the EDTA solution to this deep red solution. Boil gently until colour changes to lemon yellow. Back titrate the solution with a standardized Zinc solution until colour changes to light red at the end point(no deep red colour should appear). If the light red colour shortly turns back to lemon yellow, continuously titrate the solution until light red colour persists for more than 3minutes. Record the volume used. Repeat the titration twice and perform the blank titration using same procedure instead of taking aliquot. Calculate the mill moles of Aluminium ions in the sample.

Method C: Determination of only Mg^{2+}:-

Pipette a 10ml aliquot of the sample solution to 125ml of Erlenmeyer flask followed by adding about 15ml bicarbonate-carbonate buffer solution (pH10) add 3ml of triethanolamine (TEA) and swirl the mixture for 2minutes to enhance the formation of Al-triethanolamine complex and to mask Al-EDTA complex. Stand it for a while until turbid solution becomes mostly clear for every observation of end point. Add pinch of Eriochrome black-T indicator and mix well. The solution should appear wine red colour at this moment. Then direct titrate the solution with EDTA until colour changes to pure blue at the end point. Record the used volume of EDTA (V_{EDTA}). Repeat the titration twice. Calculate the mill moles of magnesium in antacid sample.

Method D- Determination of SiO_2 content:

Transfer the precipitation along with filter paper in previously weighed porcelain crucible. Heat the crucible on pipe clay triangle using blue flame keeping the lid slightly open (first use low flame) continue heating with strong flame till appearance of white ash. Cool the crucible and lid thoroughly and weigh it. Repeat the process of heating, cooling and weighing till constant weight is obtained.

Results:

Table-1: individual metal ion and synthetic mixture.

A] Individual metal ions:			
Method used	Observed mmoles	Expected mmoles	% error
Method-B Determination of Al^{3+} only	1.840	2.001	+8.04
Method-C Determination of Mg^{2+} only	2.057	2.060	+0.14
B]Metal ions in synthetic mixture:			
Method-A Determination of both Al^{3+}&Mg^{2+}	0.736	0.809	+9.02
Method-B Determination of Al^{3+} only	0.335	0.384	+13.02
Method-C Determination of Mg^{2+} only	0.422	0.425	+0.70

Method A-(Determination of total Al^{3+} &Mg^{2+} contents)

Brand name	Volume of EDTA used (ml)	Molarity M_{EDTA}	Mmoles of EDTA mm_{EDTA}	Volume of Zn^{2+} needed (ml) V_{Zn}	Mmoles of Zn^{2+} mm_{Zn}	Mmoles of Al^{3+} &Mg^{2+} in 10ml sample.	Average mmoles	250ml of sample	Expected mmoles	% Error
Digene-I	30.00	0.01037	0.3111	14.10 13.90 13.90	0.141 0.139 0.139	0.1701 0.1721 0.1721	0.1714	4.285	4.809	10.89
Gelusil MPS -I	40.00	0.01008	0.4032	10.90 10.90 10.90	0.109 0.109 0.109	0.2942 0.2942 0.2942	0.2942	7.355	8.025	8.34
Alcid-I	35.00	0.01008	0.3582	18.10 18.10 18.20	0.181 0.181 0.182	0.1718 0.1718 0.1708	0.1714	4.286	4.809	+10.87
Gelusil MPS-II	40.00	0.01008	0.4032	12.40 12.40 12.40	0.124 0.124 0.124	0.2792 0.2792 0.2792	0.2792	6.980	7.484	06.73
Gasidity -II	40.00	0.01008	0.4032	12.6 12.8 12.8	0.126 0.128 0.128	0.2772 0.2752 0.2752	0.2758	6.896	7.484	+07.84
Digusil-II	40.00	0.01008	0.4032	11.4 11.4 11.4	0.114 0.114 0.114	0.2892 0.2892 0.2892	0.2892	7.230	7.484	3.39

- Aliquot of sample used during each analysis= 10ml from 250ml.
- Molarity of EDTA used = 0.01M.
- mmoles of EDTA $=M_{EDTA} x V_{EDTA}$
- mmoles of Zn2+ $= M_{Zn}$ x V_{Zn}
- $mm(Al^{3+}+Mg^{2+})250 = \frac{mm(Al^{3+} + Mg^{2+})10x250}{10}$
- I= Tablet and II = Suspension.

Method B-(Determination of Al^{3+} content)

Brand name	Volume of EDTA used (ml)	Molarity M_{EDTA}	Mmoles of EDTA mm_{EDTA}	Volume of Zn^{2+} needed (ml) V_{Zn}	Mmoles of Zn^{2+} mm_{Zn}	Mmoles of Al^{3+}& Mg^{2+} in 10ml sample.	Average mmoles	250ml of sample	Expected mmoles	% Error
Digene-I	25.00	0.01037	0.2592	12.5 12.5 12.5	0.125 0.125 0.125	0.1342 0.1342 0.1342	0.1342	3.355	4.203	+20.19
Gelusil MPS -I	30.00	0.01008	0.3024	18.5 18.5 18.5	0.185 0.185 0.185	0.1174 0.1174 0.1174	0.1174	2.935	3.561	+17.57
Alcid-I	25.00	0.01008	0.2520	12.4 11.8 11.8	0.124 0.118 0.118	0.1280 0.1340 0.1340	0.1320	3.300	4.203	+21.45
Gelusil MPS-II	25.00	0.01008	0.2520	14.8 14.8 14.8	0.148 0.148 0.148	0.1040 0.1040 0.1040	0.1040	2.600	3.205	+18.87
Gasidity -II	25.00	0.01008	0.2520	14.7 14.7 14.9	0.147 0.147 0.149	0.1050 0.1050 0.1030	0.1043	2.607	3.205	+18.64
Digusil-II	25.00	0.01008	0.2520	15.4 15.4 15.4	0.154 0.154 0.154	0.0980 0.0980 0.0980	0.0980	2.450	3.205	+23.55

- Aliquot of sample used during each analysis= 10ml from 250ml.
- Molarity of EDTA used = 0.01M.
- mmoles of EDTA $= M_{EDTA} \times V_{EDTA}$
- mmoles of Zn2+ $= M_{Zn} \times V_{Zn}$
- $mm(Al3+)250 = \frac{mm(Al3+)10 \times 250}{10}$
- I= Tablet & II = Suspension.

Method C-Determination of Mg^{2+} content:

Brand name	Volume of EDTA needed(ml)	Molarity of EDTA M_{EDTA}	Mmoles of EDTA= (mmMg)10	Average mmoles	250ml of sample	Expected mmoles	% Error
Digene-I	2.40 2.40 2.30	0.01037	0.248 0.238 0.248	0.02446	0.612	0.606	-0.99
Gelusil MPS -I	17.40 17.40 17.50	0.01008	0.1753 0.1764 0.1764	0.1760	4.400	4.464	+1.43
Alcid-I	2.40 2.40 2.40	0.01008	0.0242 0.0242 0.0242	0.0242	0.6048	0.606	+0.33
Gelusil MPS-II	16.90 16.90 16.90	0.01008	0.1703 0.1703 0.1703	0.1703	4.258	4.279	+0.49
Gasidity-II	17.00 17.00 17.00	0.01008	0.1714 0.1714 0.1714	0.1714	4.284	4.279	-0.11
Digusil-II	17.10 17.10 17.10	0.01008	0.1723 0.1723 0.1723	0.1723	4.309	4.279	-0.70

- Aliquot of sample used during each analysis= 10ml from 250ml.
- mmoles of EDTA $=M_{EDTA} x V_{EDTA}$
- mmoles of Zn2+ = M_{Zn} x V_{Zn}
- $mm(Mg^{2+})250 = \frac{mm(Mg^{2+})10x250}{10}$
- I= Tablet & II = Suspension.

Method-D Determination of Silica sample

Sr.no.	Brand name of Table	Observed Mmoles	Expected Mmoles	% Error
1	Digene	0.158	0.177	+11.23
2	Gelusil-MPS	0.168	0.178	+05.43
3	Alcid	0.166	0.178	+06.65

Conclusions:

Solvent: Use of distilled water instead of demonized water.

Disintegration reagent: Use of ($HCl+HNO_3$) Acid mixture instead of HCl only because after disintegration by HCl pink colour remains as it is which interfere in titration.

SiO_2: Determination of Silica is possible, as tablet contains silicates.

Indicator: Use of Eriochrome Black-T instead of Calmagite.

Slow titration: In method B slow titration gives good result because the turning back slowly to lemon yellow colour results from the complex formation of EDTA with Zinc ion at low pH solution which is thermodynamically more stable and kinetically slower than Zn-indicator complexation.

Fast titration: In method C fast titration gives good results because if the titration is slowly the Aluminium ion will be released from Al-triethanolamine complex and generate Aluminium Eriochrome black-T complex with wine red colour so it will give highly positive error due to aluminium blocking Eriochrome black-T indicator.

% Error: Error minimization is not possible in method A and B though we changed all possible conditions like heating period, pH quantity of buffer, type of buffers (NH4Cl+NH4OH) etc.

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