International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1604-1611 www.ijprajournal.com ISSN: 2456-4494

Proton Ligand Stability Constants of Vitamin -U at Constant Temperature.

JAGDISH G GURJAR
C. U. SHAH SCIENCE COLLEGE, AHMEDABAD, GUJRAT, INDIA
Email: jagdishgurjar72@yahoo.com

Date of Submission: 08-02-2024 Date of acceptance: 23-02-2024

ABSTRACT:
The proton ligand stability constants of Vitamin -U have been determined employing Calvin – Bjerrum modified by Irving- Rossotti titration technique was ionic strength of 0.2µ using sodium perchlorate as an electrolyte. The order of stability constant was found to be $K_1 > K_2$. This technique involves the measurement of pH. Ligand Vitamin -U is soluble in water. An equiptronics EQ-610 model pH meter used in this work and readability of ± 0.01 unit. The temperature was maintained at 25 ± 0.1°C.
Key words: Irving – Rossotti method, Stability constants, Vitamin -U.

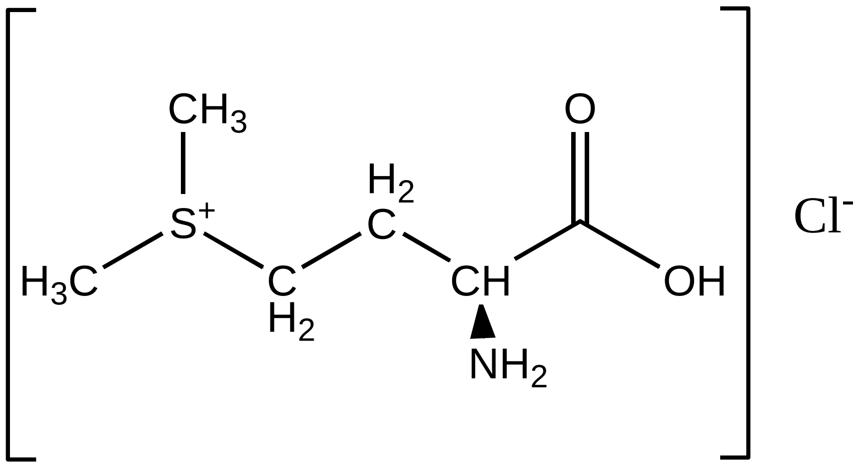
I. INTRODUCTION:

In the present work Vitamin-U has been used. The levels of Vitamin - U were detected in different varieties and anatomical parts of Brassica species. (white cabbage, red cabbage, Brussels sprouts kohlrabi, Peking cabbage etc…). The stability of Vitamin - U to storage conditions was determined also (1). Vitamin-u had protective effect against ethanol-induced injury in rats and the antiulcer effect of vitamin -u is related to its gastric mucin-increasing action (2). A previous study (3) showed that L-cysteine and vitamin- u inhibited ethanol-induced gastric mucosal damage and increased the amount of surface mucin in rats. Vitamin-u is also used in antiradiation effects (4). Cytoprotective effect of Vitamin-u on necrotizing agent-induced gastric mucosal damage in rats have been carried out (5). Akbarov et.al (6) demonstrated that the main factor in activation of Ca-dependent ATPase by cobalt complexes with vitamin- u, glycine, α – alanine etc. invention provides a therapeutic composition for using such a therapeutic composition (7). Composition for conditioning the skin and gastric mucosa have been reported (8). Experiments have been made on the investigation of the effect of Vitamin -u and nickel ions complex compounds on the processes of lipid peroxidation in rat liver (9). Vitamin -U is suitable in hair surface and for the protection of the scalps (10). Vitamin-u have been used in functional component in cabbage (11). Study of cellular strains of alfalfa resistant of vitamin-u has been carried out (12). Preventive effect of demethylation, dimethyl-β-proprotein and vitamin-u on stress induced gastric ulcers in rats (13) has been studied. Nakajima (14) have studied the effects of high concentration of demethylation, dimethyl-β- proprotein and vitamin-u on young rats. Vitamin-u electro phoresies in duodenal ulcer have been studied (15). Effect of chelate formation on the activity of Ca- ATPase cobalt (II) bio complexes with vitamin-u and glutamic acid and α – ketoglutaric cis have been carried out (16). Thermolysis study of vitamin-u with some of its Ni (II) complexes have been carried out (17). Quantitative analysis of Co – complexes with vitamin-u and glutamic acid have been carried out (18). Vitamin -U is amino acid as the name signifies, this compound contains both -NH_2 and -COOH. It also contains Sulphur and chloride atoms.

PHYSICAL PROPERTIES:
Molecular formula: $C_6H_{14}ClNO_2S$,
Molecular weight: 199.70 gm,
M.P.: 134

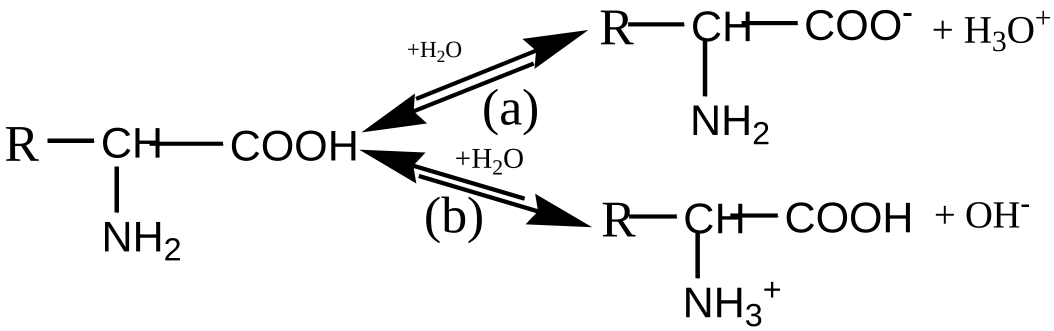
Others name: [19]
(1) Cabagin -U
(2) (s)- (3-amino-3-carboxypropyl)-dimethyl sulfonium chloride
(3) Methyl Methionine sulfonium chloride (M.M.S.C.)
(4) Epadyn-U and Vitas-U.

STRUCTURE OF VITAMIN -U:

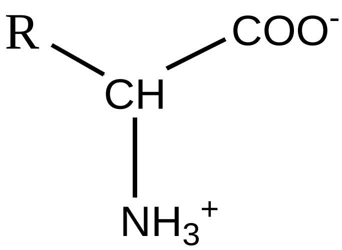


Vitamin -U

The amino acids are colorless crystalline solids generally soluble in water (except cystine which is relatively water insoluble) They are slightly soluble in alcohol and less soluble in the ether. The amino acids obtainable from protein hydrolysis. Every amino acid with a free carboxyl group and an amino group can ionize in two ways:

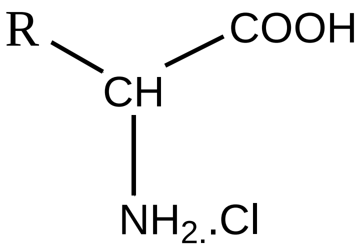


Whether an amino acid will produce excess H^+ or excess OH^{--}, depends on the pH of its solution. In alkaline solution with preponderance of OH^-, the amino acid will ionize more along path (a) because the OH^- Of the medium will take up the proton producing H_2O. This will enhance the forward reaction, giving more of the anion R-CH-COONHR. Similarly, if the medium is acid having excess H^+ then it will neutralize the OH^- produced by the amino acid and the ionization will progress along path (b) accumulations more the cation, every amino acid found to have equal concentration oh H+ and OH^- at the specific pH to. Under this condition, the H+ and OH^- completely neutralize each other and molecule has equal positive and negative charges.



Such an ion is called Zwitter (The pH at which the amino acid forms the Zwitter ion is known as its isoelectric pH or isoelectric point) ion. Amino acid can react with both acid and alkalis. The $-NH_2$ group will combine with acids to form salts. e.g.

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1604-1611 www.ijprajournal.com ISSN: 2456-4494



While the -COOH group will combine with alkalis to form salt and water as usual. Thus, titration of an amino acid by an acid and an alkali gives two different neutralization pH and hence two Pk-values will be obtained.

II. EXPERIMENTAL:

Double distilled water was used throughout the work. The pH of this water was found to be □6.8. Vitamin – U was used of A. R. grade and its standard solution of 0.1M concentration was used. other chemicals were obtained from chemical companies. The strength of NaOH solution is 0.2N and also checked by 0.2 N oxalic acid solution and also pH -metrically. The strength of $NaClO_4$ is 0.2M used in this work. All glass wares used were of Pyrex. The microburrate was calibrated to 0.02 ml as described by Vogel [20]. An equiptronics EQ-610 model control dynamics pH Meter operating on entire range from 0 to 14 having combined glass and calomel electrode was used for this works. The pH meter has readability of ± 0.01 units. The temperature was maintained by 25± 0.1°C. It was calibrated with buffer of pH 4.01,7.0 and 9.18 at 25°C.

Irving – Rossotti technique [21] was employed for the determination of proton ligand formation constants in aqueous solution. This technique involves the measurements of pH which was carried out by using a combined glass calomel electrode and pH meter assembly.

PERATION OF SOLUTION:

Following two sets of mixture were prepared (keeping total volume constant).

(1) ACID TITRATION:

Perchloric acid (0.2M) Sodium perchlorate (1M) Distilled water	5.00 ml 9.00 ml 36.00ml
Total volume	50.00 ml

(2) **LIGAND TITRATION:**

Perchloric acid (0.2M) Sodium perchlorate (1M) Ligand solution (0.1M) Distilled water	5.00 ml 8.50 ml 5.00 ml 31.50 ml
Total volume	50.00 ml

The ionic strength in each set is kept constant by adding neutral electrolyte solution. On plotting the observed pH against the volume of alkali, one obtained(a) and acid titration curve, (b) a ligand titration curve corresponding to the above titration. (fig.1)

The calculation of $\bar{n}H$ are made from the volume of alkali required to produce the same pH value in the mineral acid and ligand titrations.

According to Irving -Rossotti $\bar{n}H$ can be expressed as.

$$\bar{n}H = \frac{(\ddot{V} - V) + (N + E^{\circ})}{(\ddot{v} + \ddot{V})\dot{T}} \pm Y$$

Where,

$\bar{n}H$ = Mean number of protons bound per not complex bound ligand molecule.

$\ddot{V}$ and V = Volume of alkali required to attain same pH in the acid and (acid + ligand) curves

N = The concentration of alkali

E° = The initial concentration of mineral acid
Ṫ = The initial ligand concentration
Y = Number of replaceable hydrogens from ligand
v̀ = The initial volume of solution

The value of proton ligand stability constants has been obtained by linear plot of pH against log $\frac{\tilde{\eta}H}{1-\tilde{\eta}H}$. At each point on straight line pH + log $\frac{\tilde{\eta}H}{1-\tilde{\eta}H}$ = Pk^H.

If ῆH > 0 and < 1 formula is log $\frac{\tilde{\eta}H}{1-\tilde{\eta}H}$

ῆH > 1 and < 2 formula is log $\frac{\tilde{\eta}H-1}{2-\tilde{\eta}H}$

ῆH > 2 and < 3 formula is log $\frac{\tilde{\eta}H-2}{3-\tilde{\eta}H}$

Proton – ligand stability constants K_1^H and K_2^H values were obtained from the proton-ligand formation curves plotted between values of ῆH and pH (fig: 2 and 3) The details of intermediate stage for calculation and graphs have been represented.

Table – 1

Acid and Acid +Vitamin- U System at 25 ± 0.1°C temperature
N = 0.2M V° = 50ml $T°_{L=}$ 0.01M µ = 0.2M E° =0.02M T = 25°C

Perchloric acid Volume of alkali (ml)	B	Vitamin -U Volume of alkali(ml)	B
0.00	1.30	0.00	1.70
0.50	1.33	0.50	1.75
1.00	1.42	1.00	1.82
1.50	1.52	1.50	1.88
2.00	1.60	2.00	1.97
2.50	1.70	2.50	2.06
3.00	1.82	3.00	2.17
3.50	1.93	3.50	2.33
4.00	2.16	4.00	2.61
4.50	2.55	4.50	3.11
4.54	2.60	4.54	3.25
4.58	2.66	4.58	3.35
4.62	2.72	4.62	3.40
4.66	2.80	4.66	3.45
4.70	2.89	4.70	3.55
4.74	2.96	4.74	3.65
4.78	3.10	4.78	3.76
4.82	3.26	4.82	3.85
4.86	3.55	4.86	4.00
4.90	4.02	4.90	4.25
4.92	4.44	4.92	4.65
4.94	5.14	4.94	5.10
4.96	5.83	4.96	5.88
4.98	6.57	4.98	6.45
5.00	7.75	5.00	6.60
5.02	9.04	5.02	6.78
5.04	9.68	5.04	6.82
5.06	9.85	5.06	6.87
5.08	10.04	5.08	6.93
5.10	10.20	5.10	6.97

5.20	10.84	5.20	7.19
5.30	11.22	5.24	7.21
5.50	11.63	5.26	7.24
5.60	11.76	5.30	7.29
6.00	12.68	5.40	7.52
		5.50	7.76
		6.00	7.90

Table: II (a)
pH, V'', V', $V'' - V'$ and η̃H data of Vitamin -U System at 25°C ± 0.1°C

pH	V''	V'	$V'' - V'$	η̃H
2.50	4.38	3.74	0.64	1.259
2.55	4.42	3.81	0.61	1.246
2.60	4.48	3.94	0.54	1.218
2.65	4.60	4.10	0.50	1.201
2.70	4.62	4.16	0.46	1.185
2.75	4.64	4.20	0.44	1.177
2.80	4.66	4.25	0.42	1.169
2.85	4.70	4.32	0.38	1.152
2.90	4.74	4.38	0.34	1.136
2.95	4.78	4.47	031	1.124

Table: II (b)
pH, V'', V', $V' - V''$ and η̃H data of Vitamin -U System at 25°C ± 0.1°C

pH	V''	V'	$V' - V''$	η̃H
7.50	5.00	5.32	0.32	0.872
7.55	5.00	5.34	0.34	0.864
7.60	5.00	5.39	0.39	0.844
7.65	5.00	5.42	0.42	0.832
7.70	5.00	5.46	0.46	0.816
7.75	5.00	5.48	0.48	0.808
7.80	5.02	5.56	0.54	0.786
7.85	5.02	5.60	0.58	0.768
7.90	5.02	5.64	0.62	0.757
7.95	5.02	5.69	0.67	0.732
8.00	5.02	5.72	0.70	0.723

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1604-1611 www.ijprajournal.com ISSN: 2456-4494

Table: III (a)

pH, **ñH, log $\frac{ñH-1}{2-ñH}$ and pH + log$\frac{ñH-1}{2-ñH}$ data of Vitamin -U system at 25°C ± 0.1°C**

pH	ñH	log $\frac{ñH-1}{2-ñH}$	pH + log$\frac{ñH-1}{2-ñH}$
2.50	1.259	-0.45	2.05
2.55	1.246	-0.48	2.07
2.60	1.218	-0.54	2.06
2.65	1.201	-0.59	2.06
2.70	1.185	-0.6	2.06
2.75	1.177	-0.66	2.08
2.80	1.169	-0.70	2.10
2.85	1.152	-0.77	2.10
2.90	1.136	-0.80	2.10
2.95	1.124	-0.84	2.11

Table: III (b)

pH , ñH, log $\frac{ñH}{1-ñH}$ and pH + log$\frac{ñH}{1-ñH}$ data of Vitamin -U system at 25° ± 0.1°C

pH	ñH	log $\frac{ñH}{1-ñH}$	pH + log$\frac{ñH}{1-ñH}$
7.50	0.872	0.84	8.34
7.55	0.864	0.80	8.35
7.60	0.844	0.73	8.33
7.65	0.832	0.69	8.34
7.70	0.816	0.65	8.35
7.75	0.808	0.62	8.32
7.80	0.786	0.56	8.36
7.85	0.768	0.52	8.37
7.90	0.757	0.49	8.39
7.95	0.732	0.44	8.38
8.00	0.723	0.42	8.42

Table: IV: Proton ligand stability constants of Vitamin -U

Temperature	Ligand Name	pK_1^H	pK_2^H
25°C (±0.1)	Vitamin -U	8.36 ± 0.03	2.08± 0.03

REFERENCES:

[1]. Larina T.V., Gessler N.N., Bezzubov A.A., Eliza ova, L.G., (1-3), 99-101, (1991)
[2]. Watanabe T., Kohara S., Ichikawa, Tokafuni, Saionji, Katsunori, Hotto, Yasuko, Yakuri to Chiryo, Japan, 22(10),4355 – 4361, (1994)
[3]. Watanbe T., Kohara Sisume, Miyazqwa, SHITIROU, Saigenji Katonori, Hotto, Kyoko, J. Gestroentrol. Hepatol, Eng, 15(1),45-22, (2000)
[4]. Gessler N.N., Kharchenko L.L., Biokhim,Mikrobil, Russia,32(6),666-668,(1996)
[5]. Okabe S., Amagase K., Fujimoto S., Fujita H. (Department of Applied pharmacology, Kyoto), Ther., Res., Japan, 17 (9), 3663-3669 (1996)
[6]. Akbarvo A.B., Dubkov E.A., Mutalibov A.S., Esyrev O.V., Vashchenko V.I., Khim-farm, Zh.,Russia, 31 (5), 13 -17, (1997)
[7]. Gury j., Etter J.B., Rodell T.C., Schauer W.H., Sama N.A., PCT. International Appl. Wo, (30), 41837, (2002).
[8]. Salim AWS, Shakir Musatfa, Brit., UK Pat., Appl., G.B., 2, 177,917,04(1997).
[9]. Karimova M.M., (Tashkent Pediatric Medical Institute, Uzbekistan) Dokl.,Akad.,

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1604-1611 www.ijprajournal.com ISSN: 2456-4494

Nauk Resp., Uzbekistan Russia.12, 57-59, (1996).
[10]. Konrad Eugan, Ger., Offen.,OE.19,916,852,(2000).
[11]. Takigawa Shigenobu, (Itokkadio Natkl., Agric.,EXP,Stn., Japan) Kagaku to Seifutsu, Japan, 38(18),499-500,(2000).
[12]. Novozhilov O. V., Levenko B.A., Kultira K.I., Bioteknol M., Zh. Fiz-Khim. Biol. Biotech Nol, Russia.202 -205, (1986).
[13]. Nakajima K., Koshien Daigoka Kiyo England,A (18), 15-22,(1991).
[14]. Nakajima K., Koshien Daigoka Kiyo England, 1-8,(1990).
[15]. Khachatryan O.Ts., Grigoryan E.G., Ulashchik V.S. (Nauchno -nIssled Ints. Kurortol. Fizioter. Yerevan USSR),Vopr. Kurortol Fizioter Lech. Fiz-Kult (1986).
[16]. Mutalibov A.S., Dubkov E.A., Esyrov O.V., Vashchenko V.A., Uzb. Khim. Zh., (1997).
[17]. Akbarov A.B., Uzb.Khim.Zh. Russia , (1), 41-44, (1994)
[18]. Shadmanov K.K, Gashenko G.A., Sharipov A.K, Akbarov A.B., Yurk E.A.,Uzb. Khim. Zh. Russia, 46-48, (1993).
[19]. The Merck Index, Page no., 1713 12th edition (1996).
[20]. Vogel A.I., A Text book of Quantitative Inorganic Analysis. The ELSBS & Longmans Green and Co., Ltd., 81 – 85, 5th edi., (1989).
[21]. Irving H.M., Rossotti H.S., J. Chem. Soc., 2904 (1954)

PAPER PBLISHED

(1) Equilibrium studies on some binary chelate formation of Vitamin -U with some alkaline earth metal ions.
Asian journal of chemistry, 1517 – 1519, Vol-18 (2), 2006.

(1) Equilibrium studies on some binary complexes of Th (+4) and UO_2 (+2) With Vitamin -U at constant temperature.
Bulletin of pure and applied chemistry, 53-57, Vol.-22C,(1),2003.

(3) Equilibrium studies on some binary chelate formation of Vitamin -U with some transition metal ions.
International journal of chemical science,155-158,1(2), 2003.

(4) Equilibrium studies on some binary complex of Zn, Cd and Hg (+2) with Vitamin -U at constant temperature.
Ultra Science, 435-437, Vol.-16(3),2004

(5) Equilibrium studies on binary complex formation of La, Pr, Sm, Gd and Dy (+3) with Vitamin – U at constant temperature.
Der pharma Chemica, 113-117,2(4),2010.

Fig:1 - Acid and Acid + Vitamin – U pH against Volume of alkali at Constant temperature.

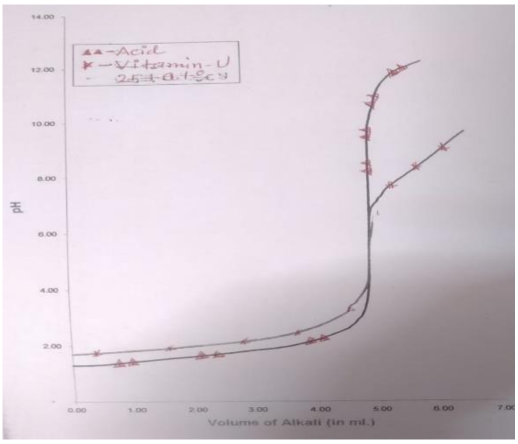
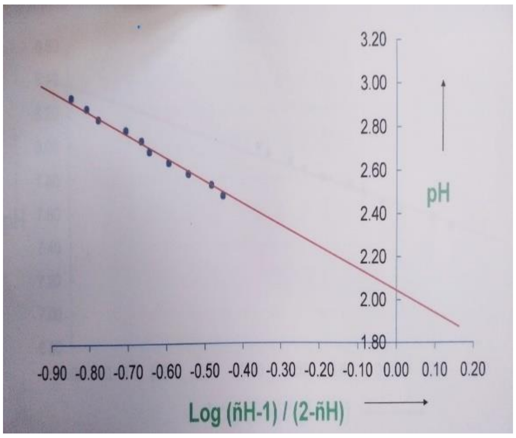


Fig: 2- (Pk_2) Proton Ligand Stability Constant Of Vitamin -U at Constant Temperature.



International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1604-1611 www.ijprajournal.com ISSN: 2456-4494

Fig: 3 - (pK_1) Proton ligand stability constant of Vitamin -U at constant temperature.