Synthesis of New Fructo – Nucleoside Analogue Derivatives

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Received: 14/6/2010, Accepted: 8/2/2011

Abstract

Tow types of nucleoside derivatives have been synthesized. To prepare the first type 1′,3′ ,4′,6′ -Tetra-O-benzoyl-β-D-fructo furanose (F_1)with a free hydroxyl group at position-2′ was chosen as the Chiron. The compound (F_1) can be easily obtained from the reaction of anhydrous D-Fructose with benzoyl chloride in pyridine. When (F_1)was treated with 45% hydrogen bromide it gave 1′ ,3′, 4′, 6′-Tetra-O-benzoyl-β-D- fructo furanose bromide(F_2).The bromo fructo benzoate (F_2) was then reacted with the proper nitrogen base (Theophylline, Adenine, Benzimidazole, Benztriazole) to give the nucleoside analogues derivatives(F_5), (F_8), (F_{11})and (F_{14}) by hydrolysis of the benzoate groups of (F_6), (F_9), (F_{12}) and (F_{15}). The newly synthesized nucleoside analogues, Guanosine nucleosides were reacted with Palmitoyl chloride in pyridine at (-12°C) to give the 6′ -O-palmitoyl, (F_7), (F10), (F13) and (F_{16}).
The prepared nucleoside derivatives were characterized from their elemental analysis and IR, ^{1}H-NMR and UV spectral data.

Introduction

Natural nucleosides and nucleotides play a key role in many biosynthesis and regulatory processes in the living cell (Marry, 1993). The purine and pyrimidine nucleotides serve as monomeric units of RNA and DNA, an energy transcription (ATP); parts of coenzymes (AMP); acceptors for oxidative phosphorylation (ADP); allosteric regulators of enzyme activity; and as second messengers, the cyclic adenosine -3, 5-monophosphate (cAMP) and cyclic guanosine--3,5-monophosphate (cGMP) (Bohinski, 1987).

Nucleoside and nucleoside analogs are a pharmacologically diverse family of molecules that have been synthesized and used for cytotoxic, antiviral, and immunosuppressive therapies (Galmarini, 2002). Adenosine, a purine nucleoside, is increasingly being found to play an important role in tumor growth and metastasis (Baldwin, 1999). Concentrations in solid tumors, with accumulation in the intracellular and extracellular tumor microenvironments, at sites of local tissue injury, and under conditions of hypoxia, and is reported to stimulate tumor growth and angiogenesis (Steve, 2006).

The pharmacological approach in the synthesis of novel drugs suggests that the use of purine nucleoside analogues in which heterocyclic structure or sugar moiety is altered in such a way that causes toxic effect when incorporated in

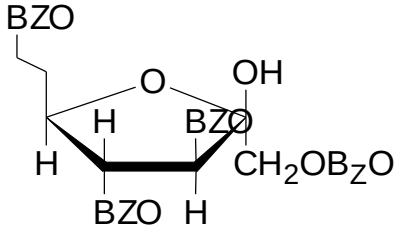
different part of the cell. Various compounds used for chemotherapy differ in their chemical structure and mechanism of action (Ljiljana, 2001).

Experimental Section

All melting points (^{o}C) were determined with sample contained in open capillary glass tubes in an electrically heated metal block apparatus (Gallen Kamp) and are uncorrected.Infra red spectra were recorded as KBr disc using a Unicam SP3- 100 SP3- 300 Infra red spectrophotometer and expressed in wave number (cm^{-1}).^{1}HNMR spectra were obtained on a Hitachi Perkin– Elmer 60 spectrometer R-24 using DMSO as solvent and (Tetramethylsilan) (TMS) as internal standard. UV spectrophotometer (LKB Ultraspec.4050).Thin layer chromatography was performed on glass plated coated with 0.25mm layer of silica gel. Micro elemental analysis (C.H.N).

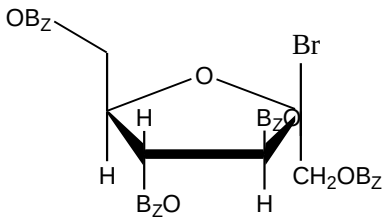
Synthesis of nucleoside analogues and 5′-palmitoyl derivatives.

1: 1′,3′ ,4′,6′ -Tetra-O-benzoyl-β-D-fructo furanose. (F_1)(Brigl, 1934).



D-Fructose anhydrous (2g, 11.11mmole) was suspend in dry CH_2Cl_2 (25ml) and pyridine (5ml).To this mixture Benzoyl chloride (7ml)was added .The mixture was stirred at (60-65) ^{o}C for (4.5 hrs.)and the reaction was monitored by TLC ($CHCl_3$:MeOH,8:2ml) .The mixture was poured over Ice –water ,then extracted with CH_2Cl_2 (2×15ml).the combined organic phase was washed with (10ml)of (1N) HCl solution and then with (10ml)of (1N)Na_2CO_3 .filter and evaporate to dryness in a vacuum to give a syrup , crystallized from absolute ethanol to give white crystal of (**F_1**)(5.10g,77% yield)m.p. (187-189) ^{o}C .IR(KBr disc),3450 cm^{-1} (OH),1710 cm^{-1} (C=O).

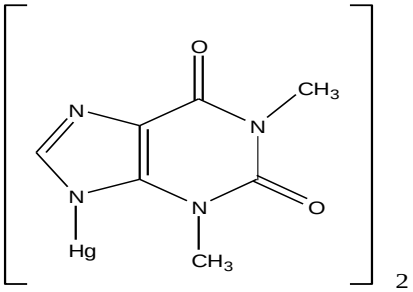
2: 1′, 3′, 4′, 6′ Tetra-O-benzoyl-β-D-fructo furanosyl bromide (F_2) (Ness, 1953).



Glacial acetic acid (10ml) was added to a solution of a benzoate sugar (**F_1**), (2g, 3.36mmole) in (10ml) (34%) HBr solution in glacial acetic acid .The mixture was stirred for 5 minuets and left for 8 hrs. at room temperature ,TLC showed that the reaction was complete. the reaction mixture was extracted with CH_2Cl_2 (2×15ml).The combined extracts was dried, filtrated and evaporate to dryness in

a vacuum to give a brown syrup(1.93g,87% yield)(**F_2**). IR film disappearance of (OH) at 3450 cm^{-1}.

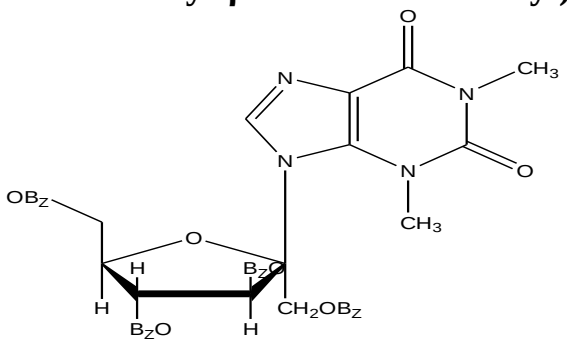
3: Bis-(Theophylline-7-yl) mercury (F3)(Freestune,1973).



Theophylline hydrate (1g, 5mmole) was dissolved in hot water (30ml) and sodium hydroxide (0.2g, 5.2mmole) was added .To the vigorously stirred solution was added a hot solution of mercuric chloride (0.7g, 2.6mmole) in ethanol (10ml) was added to the first solution with stirrering, the resulting cooled down and the product was filtered and washed with distilled water to obtain (**F_3**) (1.34g, 75% yield) m.p.>347 ^oC.

Similarly chloromercuri-adenine (**F_4**) (Davool, 1951) was prepared.

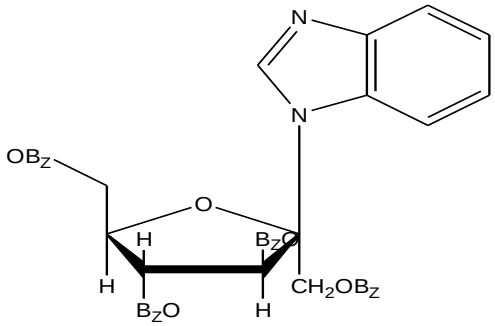
4: 7-(1′, 3′, 4′, 6′ Tetra-O-benzoyl-β-D-fructo furanosyl) theophylline (F_5)



The Benzoate sugar bromide (F_2), (1g, 1.52mmole) was added to a suspension of dried Bis-(Theophylline-7-yl) mercury **(F_3)** (0.8g, 0.211mmole) and celite (1g) in xylene (40ml).the mixture was refluxed with stirring for 3.5 hrs. at (130-135) ^oC, monitored by TLC and filtered hot, the filter cake was washed with hot chloroform (3×10ml).filtrate was evaporated in vacuum, the residue was extracted $CHCl_3$ (20ml).the combined extracts was washed with 30%aqueous potassium iodide (2×10ml.portions) and water (2×10ml.portions), then dried and filtered and evaporate to dryness in a vacuum to give a yellow syrup (0.4g, 31% yield). IR (film), 1450 cm^{-1} of (C-N).

The same method was used for the synthesis of 9-(1′, 3′, 4′, 6′ tetra-O-benzoyl-β-D-fructo furanosyl) adenine (**F_8**).

5: 1-(1′, 3′, 4′, 6′-Tetra-O-benzoyl-β-D-fructo furanosyl) benzimidazole (F_{11})

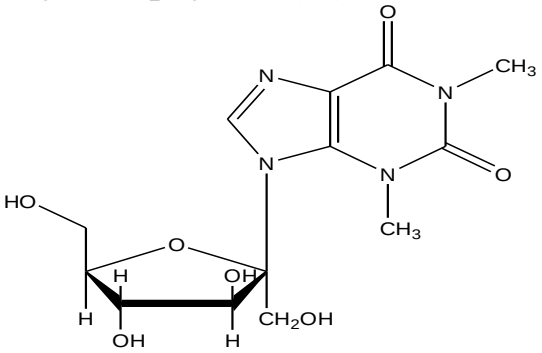


A mixture of Benzoate sugar bromide (F_2), (1.5g, 2.28mmole),mercueicyanide (1.0g)anhydrouse calcium sulphate (1.0g)was added to a solution of benzimidazole (0.5, 0.42mmole)in nitromethane (100ml).the mixture was refluxed with stirring for 6 hrs., monitored by TLC.the mixture was filtered hot and the filter cake was washed with (20ml)of hot nitermethane.the filtrate was combined with washing and the combined evaporated to produce yellow syrup (0.4g,26% yield).

IR (film), 14350 cm $^{-1}$ of (C-N).

The same method was used for the synthesis of 1-(1′, 3′, 4′, 6′ tetra-O-benzoyl-β-D-fructo furanosyl) benztriazol (**F_{14}**).

6: 7-β-D-fructo furanosyl theophylline (F_6).



7-(1′,3′ ,4′,6′ tetra-O-benzoyl-β-D-fructo furanosyl)theophylline (**F_5**) (1g, 1.32mmole) in 0.08M methanolic sodium methoxide (45ml).The mixture was refluxed with stirring for 1.5 hrs, then neutralized with glacial acetic acid and evaporated to dryness, the residue was partitioned between water and chloroform and the aqueous phase was evaporated .to give a white powder (0.34g,76% yield).

IR (KBr disc), 3360 cm $^{-1}$ of (OH).

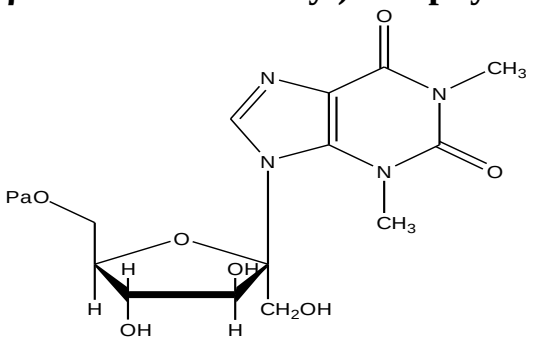
This method was also used to obtain:

9-β-D-fructo furanosyl adenine (**F_9**)

1-β-D-fructo furanosyl benzimidazole (**F_{12}**)

1-β-D-fructo furanosyl benztriazol (**F_{16}**)

7: 7-(6′ -O-palmitoyl-β-D-fructo furanosyl) theophylline(F_7)



7-β-D-fructo furanosyl theophylline (**F_6**) (0.5g, 1.46mmole) was suspended in CH_2Cl_2 (15ml) and pyridine (3ml) was added. To this mixture palamatoyl chloride (0.4g) was added. The mixture was stirred at (-12 ^oC) for 4hrs and the reaction monitored by TLC ($CHCl_3$: MeOH, 8:2ml).The reaction poured into ice water, then was extracted with CH_2Cl_2 (2×10ml).The organic phase was dried over anhydrous sodium sulphate and filtrated. The filtered was evaporated to dryness in a vacuum to give syrup (0.66g, 81% yield). IR (film), 1750 cm^{-1} of (C=O) for palmatoyl group.

This method was also used to prepare:

9-(6′ -O-palmitoyl-β-D-fructo furanosyl) adenine. (F_{10}).

1-(6′ -O-palmitoyl-β-D-fructo furanosyl) benzimidazole. (F_{13}).

1-(6′ -O-palmitoyl-β-D-fructo furanosyl) benztriazol. (F_{16}).

Results and Discussion

Chemical synthesis:-

For the synthesis of the type of nucleoside analogues, D-fructose was first converted to 1′,3′ ,4′,6′ -Tetra-O-benzoyl-β-D-fructo furanose(F1).The reason for conversion of D-fructose to (F1) was to protect the hydroxyl groups with a benzoate group which is known to be stable toward acid conditions, but are readily hydrolyzed by dilute alkaline(Iwai, 1968).

The compound (F1) was obtained when D-Fructose was treated with benzoyl chloride.IR spectrum showed a stretching band at 3450cm-1

for the C-2 hydroxyl group, a stretching band at 1710cm-1for the (C=O)ester group and 1590cm-1for the (C=C)aromatic bands.

Treatment of (F1) with a solution of 45%HBr in glacial acetic acid gave 1′, 3′, 4′, 6′ Tetra-O-benzoyl-β-D-fructo furanosyl bromide (F2) in 87% yield .The IR spectrum of (F2)showed the (C-Br)stretching band at 750 cm-1 and disappearance of (OH) stretching band at 3450 cm-1. The elemental analysis date showed in table (1).

Synthesis of 7- (1′, 3′, 4′, 6′ Tetra-O-benzoyl-β-D-fructo furanosyl) theophylline (F_5)

The compound (**F_5**) was obtained as a syrup in 30.7% which was characterized by IR, showed a stretching band at 1450 cm^{-1} for the (C-N) band, stretching

band at 1530 cm^{-1} for (C=N) band and a band at 1690 cm^{-1} for (C=O) amide, UV spectral showed an a absorption a λ_{max} at 210 nm due to π→ π * transition of (C=C) group of aromatic ring for benzoate group. A λ_{max} at 255 nm due to π→π* transition of dienone system (C=C-C=O) of the theophylline ring and benzoate group, and λ_{max} at 283 nm due to π→ π * transition which indicate the presence of the (C=N) group. The elemental analysis date showed in table (1).

Synthesis of 9-(1′, 3′, 4′, 6′ tetra-O-benzoyl-β-D-fructo furanosyl) adenine (F_8).

Similarly, the compound (**F_8**) was obtained as a syrup in 38.4% yield, which was characterized by IR, showed a stretching band at 1570 cm^{-1} for the (C=C) band, stretching band at 1470 cm^{-1} for (C=N)**,** a stretching band at 1690 cm^{-1} for carbonyl (of the benzoate group) and elemental analysis date showed in table (1).

Synthesis of 9-(1′, 3′, 4′, 6′ tetra-O-benzoyl-β-D-fructo furanosyl) benzimidazole (F_{11}).

Compound (**F_{11}**) was obtained also as a syrup in 25.8% yield, which was characterized by IR, showed a stretching band at 3040 cm^{-1} for the aromatic (C-H), stretching band at 1510 cm^{-1} for (C=N)**,** a stretching band at 1690 cm^{-1} for carbonyl (of the benzoate group) and elemental analysis date showed in table (1).

Synthesis of1- (1′, 3′, 4′, 6′tetra-O-benzoyl-β-D-fructo furanosyl) benztriazol (F_{14}).

The reaction of the compound (F_2) in a similar manner with benztriazole gave the desired compound (F_{14}) as a syrup in 37.8% yield, which was characterized by IR, showed a stretching band at 3100 cm^{-1} for the aromatic (C-H), stretching band at 1525 cm^{-1} for (N=N), a stretching band at 1720 cm^{-1} for carbonyl (C=O) and elemental analysis date showed in table (1).

Hydrolysis of benzoate groups

Treatment of the theophylline nucleoside analogue (F_5) with a sodium methoxide solution under reflux gave 7-β-D-fructo furanosyl theophylline (F_6) that was obtained as a whit crystals in 75.6% yield, which was characterized by IR, showed a stretching band at 3430 cm^{-1} for the (O-H) group, the UV spectral showed an a absorption a λ_{max} at 210 nm due to π→ π * transition of (C=C) group of aromatic ring for benzoate group.

Hydrolysis of the benzoate ester (F_9), (F_{12}) and (F_{15}) was performed in the same manner which gave the expected products. All these compounds were proved by IR spectrum .The compound (F_9) structure was proved also by ^{1}HNMR and the spectral data showed in the table (2).the elemental analysis for (F_9), (F_{12}) and (F_{15}) are shown in table (1).

Synthesis of 6′-O-palmitoyl nucleoside analogue fructo derivatives and 5′-palmitoyl nucleoside.

One of the aims of the present work was to block the 5′-position of known nucleosides and the 6′-position of the newly synthesized nucleoside analogue with a lipophilic group such as palmatoyl group.

The nucleoside analogue (F_6),(F_9),(F_{12}),(F_{15})and nucleoside guanosine was individually treated with palmatoyl chloride to give the compounds (F_7),(F_{10}),(F_{13})and(F_{16}).

The compound (F_7) was characterized by its IR, showed a stretching band at 3450 cm^{-1} for the (O-H) group, showed a stretching band at 3080 cm^{-1} for the aromatic (C-H), a stretching band at 1710 cm^{-1} for carbonyl group, the ^{1}HNMR spectral data were shown in the table (2) and elemental analysis date showed in table (1). The UV spectral showed an absorption a λ_{max} at 240 nm due to $\pi \rightarrow \pi^*$ transition of (C=O) group of palmatoyl group.

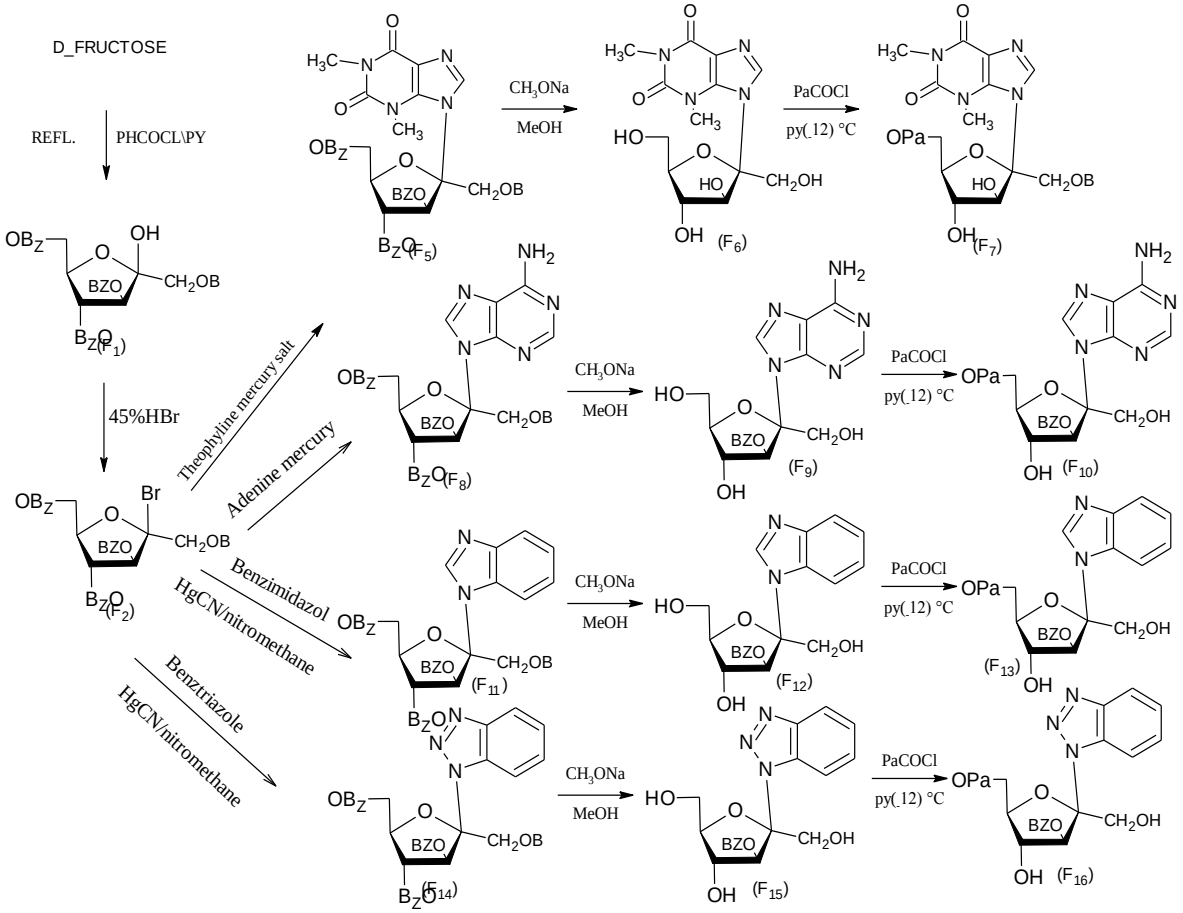
Compound (F_{10}): IR spectrum showed a stretching band at 3390 cm^{-1} for the (O-H) group, showed a stretching band at 1600 cm^{-1} for the (C=C)stretching, a stretching band at 1710 cm^{-1} for carbonyl group .

Compound (F_{13}): IR spectrum showed a stretching band at 3390 cm^{-1} for the (O-H) group, showed a stretching band at 1600 cm^{-1} for the (C=C)stretching, a stretching band at 1720 cm^{-1} for carbonyl group(of palmatoyl group) .

Compound (F_{16}): IR spectrum showed a stretching band at 3480 cm^{-1} for the (O-H) group, showed a stretching band at 3080 cm^{-1} for the aromatic (C-H), a stretching band at 1710 cm^{-1} for carbonyl group(of palmatoyl group)and band at 1540 cm^{-1} for(N=N) stretching.

Table (2) shown the ^{1}HNMR spectrum data for the compounds (F_{10}), (F13), (F16), the table (1) showed the elemental analysis data for the above compounds.

The scheme (1) below showed the reaction way of synthesis of nucleoside analogues (F_6),(F_9),(F_{12}),(F_{15})and 6′-O-palmitoyl nucleoside analogues(F_7),(F_{10}),(F_{13}),(F_{16}).



Scheme (1)

Table (1): The physical properties of synthesized compounds

Comp. No.	Name of compounds	Melting point °C	Percent (%)	Molecular formula	Elemental analysis					
					Calc,			found		
					%C	%N	%H	%C	%N	%H
F_5	7-(1',3',4',6'tetra-O-benzoyl-β-D-fructo furanosyl)theophylline	syrup	30.70	$C_{41}H_{34}O_{11}N_4$	64.91	7.39	4.49	64.77	7.24	4.27
F_6	7-β-D-fructo furanosyltheophylline	244-246	75.6	$C_{13}H_{18}O_7N_4$	45.61	16.37	5.26	45.47	16.50	5.42
F_7	7-(6'-O-palmitoyl-β-D-fructo furanosyl)theophylline	syrup	81.3	$C_{29}H_{48}O_7N_4$	61.70	9.93	8.51	61.54	9.74	8.47
F_8	9-(1',3',4',6'tetra-O-benzoyl-β-D-fructo furanosyl)adenine	syrup	38.42	$C_{39}H_{31}O_9N_5$	65.64	9.82	4.34	65.95	9.37	4.49
F_9	9-β-D-fructo furanosyl adenine	238-240	81.25	$C_{11}H_{15}O_5N_5$	45.99	24.39	5.22	45.87	24.19	5.42
F_{10}	9-(6'-O-palmitoyl-β-D-fructo furanosyl) adenine	syrup	88.16	$C_{27}H_{45}O_6N_5$	60.56	13.08	8.41	60.72	13.17	8.38
F_{11}	1-(1',3',4',6'tetra-O-benzoyl-β-D-fructo furanosyl)benztriazol	syrup	25.83	$C_{41}H_{32}O_9N_2$	70.81	4.02	4.59	70.99	4.17	5.13
F_{12}	1-β-D-fructo furanosylbenzimidazole	214-216	77.11	$C_{13}H_{16}O_5N_2$	55.71	10.00	5.71	55.58	9.79	5.97
F_{13}	1-(6'-O-palmitoyl-β-D-fructo furanosyl) benzimidazole	syrup	71.72	$C_{29}H_{46}O_6N_2$	67.18	5.41	8.82	67.35	5.66	8.72
F_{14}	1-(1',3',4',6'tetra-O-benzoyl-β-D-fructo furanosyl) benztriazol	syrup	37.82	$C_{40}H_{31}O_9N_3$	68.87	6.02	4.45	68.68	6.24	4.56
F_{15}	1-β-D-fructo furanosyl benztriazol	194-196	77.81	$C_{12}H_{15}O_5N_3$	51.25	14.95	5.34	51.09	14.77	5.25
F_{16}	1-(6'-O-palmitoyl-β-D-fructo furanosyl) benztriazol	syrup	61.8	$C_{28}H_{45}O_6N_3$	64.74	8.09	8.67	64.53	8.26	8.95

Table (2): HNMR Spectral Data

	NMR Data PPm(δ)							
Comp. No.	**H-1**	**H-2**	**H-3**	**H-4**	**H-5**	**H-6**	**Palmatoyl group**	**Remarks**
F_7	2.9 (s,2H)	-	4.99 (1H)	4.40 (1H)	3.8 (1H)	2.6 (s,2H)	1.0-2.4 (m,28H) 0.9 (t,3H)of CH_3	2.8 (s,6H)for two methyl group and 7.9(s.1H)for theophyllin ring protons
F_9	3.2 (s,2H)	-	5.3 (1H)	4.8 (1H)	3.8 (1H)	2.9 (s,2H)	-	3.4 (s,2H)for amino group and 7.5-7.9(m.1H)for Adenine ring protons
F_{13}	2.6 (s,2H)	-	5.1 (1H)	4.6 (1H)	3.9 (1H)	2.5 (s,2H)	1.2-2.4(m,28H) 1.1 (t,3H)of CH_3	7.8 (m,5H)for benzene ring and 7.5-8.2(m.1H)for Benzimidazole ring protons
F_{16}	2.6 (s,2H)	-	5.1 (1H)	4.5 (1H)	3.7 (1H)	2.4 (s,2H)	1.0-2.3(m,28H) 0.9 (t,3H)of CH_3	7.8(m.5H)for Benztriazole ring protons

S:singlet,d:doubley,m:multipalte

References

- Marry,R.; Cranner,D.; Mayes,D.; Well,V., (1993): Harper's Biochemistry London: Prentice-Hall International, 23rd ed, ISBN 0838536581 (pbk), 333 P.
- Bohinski,R.; (1987): Modern Concepts In Biochemistry Boston: Allyn and Bacon, 5th ed, ISBN 020508852X, 236 P.
- Galmarini C.; Mackey J.; Dumontet C., (2002): Nucleoside analogues and nucleobases in cancer treatment. The lancet oncology, Vol. 3, Issue 7, pp.415-424.
- Baldwin, S.; Mackey, J.; Cass, C., (1999): Nucleoside Transporters: Molecular Biology And Implications For Therapeutic Development Molecular Medicine Today, Vol. 5, Issue 5, pp.216-224.
- Steve, Y.; Josh, P.; James, M.; John, H.; (2006): In Vitro Evaluation of Adenosine 59-Monophosphate as an Imaging Agent of Tumor Metabolism, The Journal. Of Nuclear Medicine, Vol. 47, No. 5, pp. 837–845.
- Ljiljana,A., (2001): The Effect Of Nucleoside Analogues On Biochemical Parameters In Rats Sera Archive Of Oncology, vol.9, No.3, 155p.
- Spychala,J., (2000): Tumor-Promoting Functions of Adenosine. Pharmacology and therapeutics, Vol.87, 173 p.
- Ness,R.;Fletecher,H., (1953): Prepaation Of Crystalline 2,3,5-Tri-O-Benzotl-D-Ribose Fromd-Ribose , Journal American chemical society, vol.75, 3289 P.
- Freestone,A.;Richardson,A., (1973): A Convenient Procedure For The Synthesis Of Theophylline Nucleosides Carbohydrate Reseach, vol.28, pp.378-368.
- David C.,Cecil C. (1972): The Effect Of Structural Modifications Of Atp On The Yeast–Hexo Kinase Reaction European Journal Biochemistry,Vol.31, pp.180-185.
- Iwai,I.;Nishimura,T.;Shimizu,B., (1968): Synthetic Procedures In Nucleic Acid Chemistry, Published by Interscience Publishers in New York, ISBN 0471984183.

تحضير بعض مشتقات فركتوز نيوكليوسيد الجديدة

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تاريخ الاستلام:٢٠١٠/٦/١٤، تاريخ القبول:2011/2/8

الخلاصة

يتضمن البحث تحضير نوعين جديدين من مشتقات النيوكلوسيد. النوع الأول يتضمن مشتقات أشباه نيكلوسيدات مشتقة منβ–D– فركتوز ومن ثم تحويلها إلى أسترات البالمتيك، أما النوع الثاني فقد يتضمن تحوير النيوكلوسيد المشتق من الكوانوسين وذلك بتحويلها إلى المشتق ٥′–O– بالمتيل عن طريق تفاعل الاستر باستعمال كلوريد البالمتيل. لتحضير النوع الأول اختير المركب ٦،٤،٣،١– رباعي –O–بنزوات – β–D– فركتوفيوارنوز (F_1) الذي يحتوي على مجموعة هيدروكسيل حرة في الموقع – ٢–كمادة أولية كيرالية. ويمكن الحصول على (F_1) بسهولة بتفاعلβ–D– فركتوز مع كلوريد البنزويل.

عند تفاعل (F_1)مع ٤٥% (HBr) تم الحصول على بروميد ٦،٤،٣،١– رباعي– O–بنزوات–β –D – فركتوفيوارنوز (F_2)وبتفاعل الأخير مع القاعدة النتروجينية المناسبة (ثايوفيلين، ادنيين، بنزامايدازول، بنزاترايزول) تم الحصول على أشباه النيكلوسيدات (F_5)، (F_8)، (F_{11})، (F_{14}).

إن التحلل المائي القاعدي لمجموعة البنزوات بواسطة ميثوكسيد الصوديوم أدى إلى الحصول على أشباه النيكلوسيدات الحرة (F_6)، (F_9)، (F_{12})، (F_{15}).

أجريت بعد ذلك تفاعل الاسترة بكلوريد البالمتيل مع أشباه النيكليوسيدات للحصول على المشتق ٦′–O– بالمتيل (F_7)،(F_{10})، (F_{13})، (F_{16}).

تم تشخيص المركبات المحضرة بواسطة أطياف الأشعة تحت الحمراء ،الرنين النووي المغناطيسي،والفوق البنفسجية، والتحليل الدقيق للعناصر(C,H,N).