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REACTIONS OF L-ASCORBIC AND ISOASCORBIC ACIDS WITH HYDRAZINES RELATED TO SULFANILAMIDE DRUGS*

RAAFAT SOLIMAN*, EL SAYED H EL ASHRY**, IBRAHIM E EL KHOLY**, AND YELDEZ EL KILANY**

**Pharmaceutical Chemistry Department Faculty of Pharmacy and **Chemistry Department, Faculty of Science, Alexandria University, Alexandria (Egypt)*

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ABSTRACT

Various compounds related to the antibacterial, sulfanilamide drugs have been prepared from dehydro-L-ascorbic acid or its D-*erythro* analog by reaction with hydrazines related to sulfanilamide sulfadiazine sulfamerazine, sulfamethazine, and sulfamethoxydiazine whereby the 2-mono- and 2,3-bis-(hydrazone) were isolated After opening of the lactone ring in the bis(hydrazones) with alkali, nucleophilic attack, on the carbonyl group, of the imino nitrogen atom of the 3-hydrazone residue afforded 3-(L-*threo*-glycerol-1-yl)-1-phenyl- and -1-(*p*-sulfamylphenyl)-4,5-pyrazoledione 4-(*p*–sulfamylphenylhydrazone) and the related 3-(D-*erythro*-glycerol-1-yl) compounds Whereas acetylation of L-*threo*-2,3-hexodiulosono-1,4-lactone 2 3-bis(*p*-sulfamylphenylhydrazone) (**9**) and 3-(L-*threo*-glycerol-1-yl)-1-(*p*-sulfamylphenyl)-4,5-pyrazoledione 4-(*p*-sulfamylphenylhydrazone) (**15**) gave the *O*-acetyl derivatives, benzoylation of **15** gave the di-*N*-benzoyltri-*O*-benzoyl compound Reaction of **9** with cupric chloride gave 3,6-anhydro-3-(*p*-sulfamylphenylazo)-L-*xylo*-2-hexulosono-1,4-lactone 2-(*p*-sulfamylphenylhydrazone) The 3-(L-*threo*-glycerol-1-yl)-1-(*p*-sulfamylphenyl)flavazole (**35**) was prepared by the rearrangement of 3-[(1-*p*-sulfamylphenyl)hydrazono-L-*threo*-trihydroxybutyl]-2-quinoxalinone (**33**) Periodate oxidation of **15**, **33**, and **35** gave 3-formyl-1-(*p*-sulfamylphenyl)-4,5-pyrazoledione 4-(*p*-sulfamylphenylhydrazone), 3-{1-[(*p*-sulfamylphenyl)hydrazono]glyoxal-1-yl}-2-quinoxalinone, and 3-formyl-1-(*p*-sulfamylphenyl)flavazole, respectively The ir and nmr spectral data for some of these derivatives are reported

INTRODUCTION

Sulfanilamide antibacterial drugs[3], now in their fifth decade, continue to be used because they are effective, inexpensive, and free from the superinfection problems associated with the broad-spectrum antibiotics They have proved to be quite safe, even when widely used in ambulatory patients, an application in which they are often

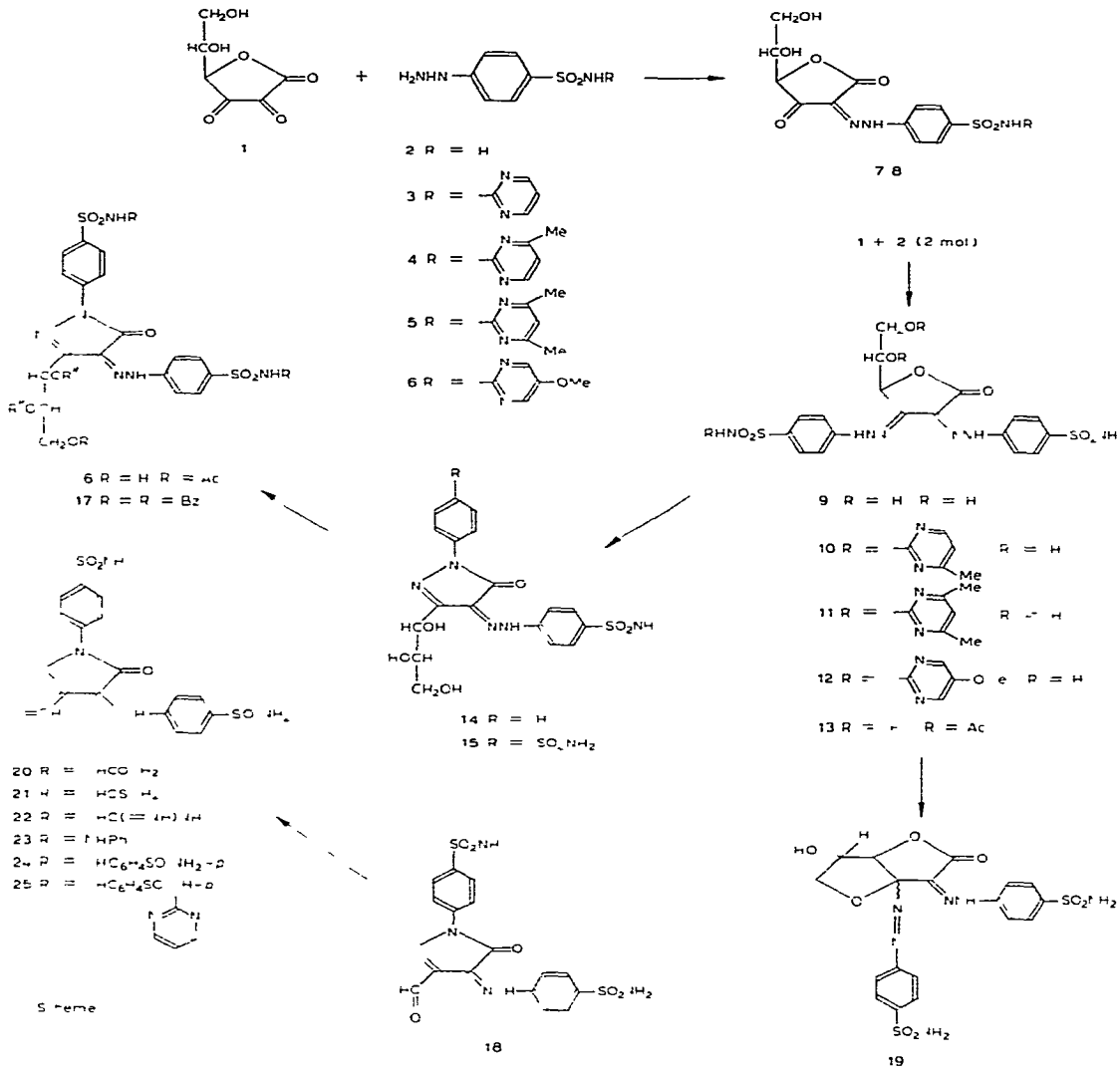
*Part VIII of 'The Scope of the Reaction of Hydrazines and Hydrazones", for Part VII, see ref 1 Part IX of "Heterocycles from Carbohydrate Precursors , for Part VIII, see ref 2

preferred Most of the original problems of toxicity have been resolved, and, during the past two decades, the sulfanilamide drugs have withstood critical evaluation alongside the antibiotics, which have problems of their own During this period, active compounds providing a wide range of choice in all of the pertinent pharmacological properties, and having lower toxicity, have been synthesized, and a wide spectrum of activity has been established For example, Fanasil, a new entry in the field of the antibacterial, sulfanilamide group, possesses both a wide spectrum of activity and a long duration of action

Since its discovery as a biologically important molecule, dehydro-L-ascorbic acid (**1**) has attracted attention in studies of its products of reaction with other chemotherapeutic agents, for example, because of its acidic properties, formation of its salts with amines has been examined Some sulfanilamide drugs have been studied[4-5] in this respect, and for the adducts formed, a lower toxicity and enhanced therapeutic properties in comparison with those of the free sulfanilamide derivatives have been reported In connection with a program concerned with the reaction of (*a*) hydrazines related to sulfanilamide drugs[6], and (*b*) dehydro-L-ascorbic acid[7-12], this prompted us to study their condensation in this way, products consisting of derivatives of the heterocyclic rings bearing carbohydrate moieties and still possessing the active part of the sulfanilamide drugs have been synthesized for study of their potential activity as sulfanilamide-related, antibacterial agents

RESULTS AND DISCUSSION

The reaction of hydrazines **2–6** (derived from sulfanilamide, sulfadiazine sulfamerazine, sulfamethazine or sulfamethoxydiazine) with L-*threo*-2,3-hexodiulosono-1 4-lactone (dehydro-L-ascorbic acid **1**) was studied (see Scheme 1) When the reaction was conducted with **2** or **3** in aqueous alcoholic solution at room temperature, with equimolar amounts of both reactants the corresponding 2-monohydrazones (**7** and **8**) were obtained Whereas the 2-(*p*-sulfamylphenylhydrazone) (**7**) of dehydro-L-ascorbic acid was amorphous, the 2-[*p*-(pyrimidinylsulfamyl)phenylhydrazone] (**8**) was crystalline On the other hand, when the reaction of **1** was conducted with two molar equivalents of hydrazines **2–6** under the influence of heat, the corresponding 2,3-bis(*p*-substituted sulfamylphenylhydrazones) (**9–12**) were obtained in crystalline form The 2,3-bis(*p*-sulfamylphenylhydrazone) (**9**) could also be prepared from the monohydrazone **7** by reaction with (*p*-sulfamylphenyl)hydrazine (**2**) Both the 2-mono- and the 2,3-bis-(hydrazone) were readily distinguished by their color, as well as by their infrared (i r) spectra, the 2-monohydrazones showed a carbonyl band in addition to the lactone band, whereas the bishydrazones showed only the lactone band The mono- and bis-hydrazones were formulated in the 1,4-lactone structures **7–12**, analogous to the previously established structures for similar compounds The n m r spectrum of **9** showed, in addition to the aromatic protons at δ 7 2–8 0, peaks centered at δ 4 9–5 6 and 3 5–4 3 due to H-4, H-5, and H-6 6′, respectively, of the sugar residue



Acetylation of the bis[(*p*-sulfamylphenyl)hydrazone] **9** afforded the diacetyl derivative (**13**), which showed, in its i r spectrum, an unresolved band at 1725 cm^{-1} due to the lactone and the acetyl carbonyls Opening of the lactone ring in **9** with alkali, followed by acidification, gave the rearranged product 3-(L-*threo*-glycerol-1-yl)-1-(*p*-sulfamylphenyl)-4,5-pyrazoledione 4-[(*p*-sulfamylphenyl)hydrazone] (**15**) which, on acetylation, gave the corresponding tri-*O*-acetyl derivative (**16**), and, on benzoylation the di-*N*-benzoyl-tri-*O*-benzoyl derivative **17**

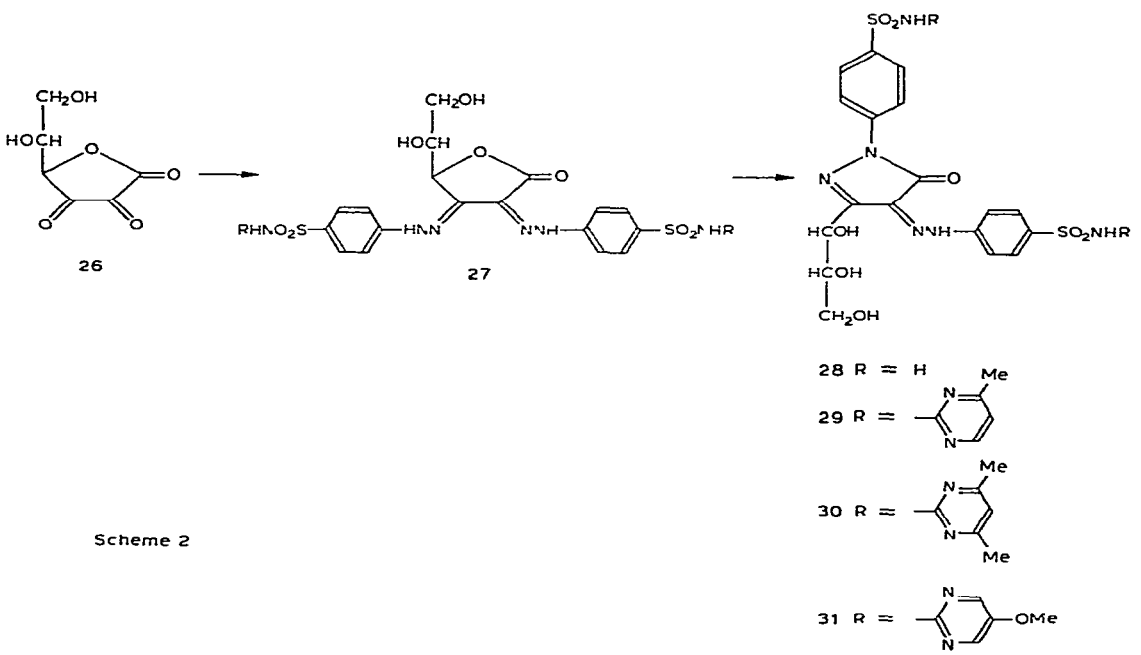
Attempts to prepare the mixed bishydrazone L-*threo*-2,3-hexodiulosono-1,4-lactone 3-(2-phenylhydrazone) 2-[2-(*p*-sulfamylphenyl)hydrazone] from the amorphous compound **7** afforded a product that could not be crystallized, but was characterized

by rearranging it into the pyrazoledione **14** Periodate oxidation of **15** afforded 3-formyl-1-(*p*-sulfamylphenyl)-4,5-pyrazoledione 4-[(*p*-sulfamylphenyl)hydrazone] (**18**), that gave the corresponding hydrazones (**20–25**) The structures of the pyrazolediones **14–18** were characterized by their i r spectra, which showed the OCN band at 1680–1660 cm^{-1}

The n m r spectrum of **15** showed the trihydroxypropyl side-chain at δ 3 9, 4 7, and 5 3, and the aromatic protons at δ 7 6 The n m r spectrum of its acetate **16** showed three singlets, at δ 1 88, 2 00, and 2 12, due to the three acetyl groups The side chain appeared as two multiplets centered at δ 4 24 and 5 68, due to H-3, 3′, and 2, and a doublet centered at δ 6 12 due to H-1, the aromatic protons appeared as a multiplet centered at δ 7 2

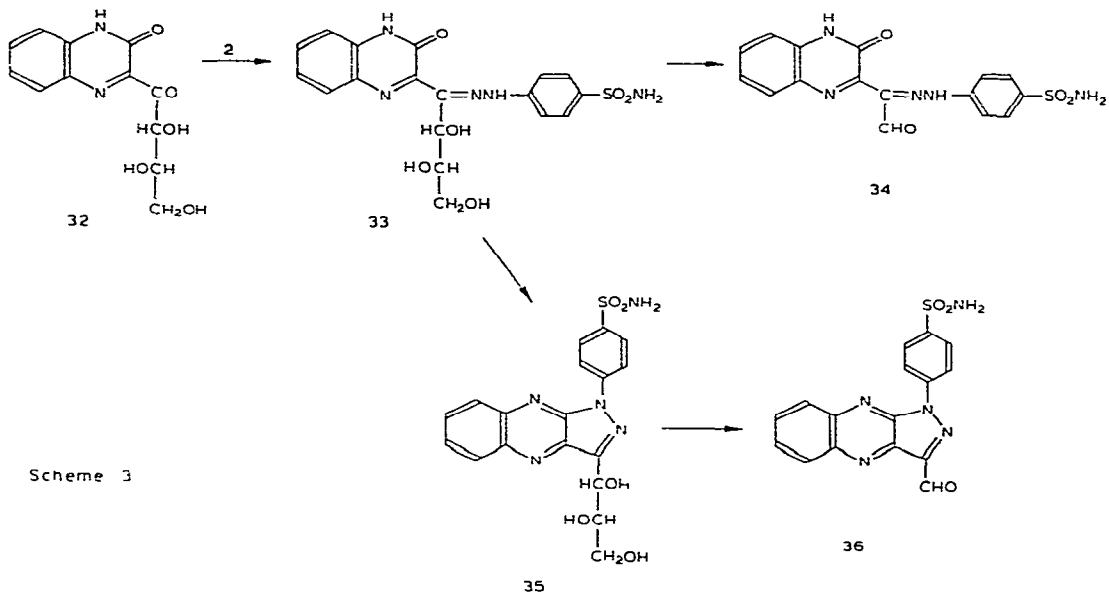
Reaction of **9** with cupric chloride afforded a crystalline, yellow derivative (**19**) which was formulated as being similar to the reaction product of the bis(phenylhydrazone) Its n m r spectrum showed peaks centered at δ 4 3, 5 2, and 5 8 (due to the sugar residue) and δ 7 6 (due to the aromatic protons)

An analogous series of compounds related to the sulfanilamide drugs was obtained from D-*erythro*-2,3-hexodiulosono-1,4-lactone (dehydroisoascorbic acid, **26**) Thus, reaction of **26** with the hydrazines **2–6** (related to sulfanilamide, sulfamerazine, sulfamethazine, and sulfamethoxydiazine) gave products that proved to be difficult to crystallize and were therefore converted directly into the pyrazolediones (**28–31**) which contain a D-*erythro* side-chain



Scheme 2

When the reaction product (**32**) of *o*-phenylenediamine with dehydro-L-ascorbic acid (**1**) was allowed to react with (*p*-sulfamylphenyl)hydrazine (**2**), it gave 3-[(1-(*p*-sulfamylphenyl)hydrazono-L-*threo*-2,3,4-trihydroxybutyl]-2-quinoxalinone (**33**), which, upon periodate oxidation, gave 3-{1-[(*p*-sulfamylphenyl)hydrazono]glyoxal-1-yl}-2-quinoxalinone (**34**) Rearrangement of **33** with alkali gave 3-(L-*threo*-glycerol-1-yl)-1-(*p*-sulfamylphenyl)flavazole (**35**), characterized by its yellow color, which, on periodate oxidation, gave the aldehyde **36**



EXPERIMENTAL

General methods — Melting points were determined with a Kofler-block apparatus and are uncorrected I r spectra were recorded with a Unicam SP-200 spectrophotometer, and n m r spectra (for solutions in Me_2SO-d_6) with a Jeol-100 spectrometer Chemical shifts are given on the δ scale, with tetramethylsilane ($\delta = 0$) as the standard Elemental analyses were performed in the Microanalytical Laboratory, Faculty of Science, University of Cairo, Cairo, Egypt

L-threo-*2,3-Hexodiulosono-1,4-lactone 2-*{*2-*[p-(*2-pyrimidinylsulfamyl)phenyl*]-*hydrazone*} (**8**) — A solution of dehydro-L-ascorbic acid, obtained by the oxidation of L-ascorbic acid (0 01 mol), in water (50 mL) was treated with 4-hydrazino-*N*-(2-pyrimidinyl)benzenesulfonamide (**3**) (0 01 mol) The mixture was kept overnight at room temperature, whereby a yellow, crystalline product separated out (yield 65%) It was recrystallized from ethanol in yellow crystals, m p 180–182°, ν_{max}^{Nujol} 1750 (COO) and 1670 cm^{-1} (CO)

Anal Calc for $C_{16}H_{15}N_5O_7S$ C, 45 6, H, 3 6, N, 16 6 Found C, 45 9, H, 3 5, N, 17 0.

L-threo-*2,3-Hexodiulosono-1,4-lactone 2,3-bis*(p-*sulfamylphenylhydrazone*) (**9**).— A solution of dehydro-L-ascorbic acid (9 g) in water (200 mL) was treated with (*p*-sulfamylphenyl)hydrazine (19 g), and the mixture was heated for 30 min The red product that separated out (yield 70%) was filtered off, successively washed with water, ethanol, and ether, and recrystallized from ethanol; m p 267–270°, ν_{max}^{Nujol} 1720 cm^{-1} (COO)

Anal Calc for $C_{18}H_{20}N_6O_8S_2$ C, 42 2, H, 3 9, N, 16 4, S, 12 5 Found C, 42 3, H, 4 2, N. 16 7, S, 12 1

L-threo-*2,3-Hexodiulosono-1,4-lactone 2,3-bis*(p-*substituted-sulfamylphenylhydrazones*) (**10–12**) — These were prepared similarly to **9** (see Table I)

5,6-Di-O-*acetyl*-L-threo-*2,3-hexodiulosono-1,4-lactone 2,3-bis*(p-*sulfamylphenylhydrazone*) (**13**) — A solution of compound **9** (0 5 g) in pyridine (15 mL) was treated with acetic anhydride (5 mL), and kept overnight at room temperature The mixture was poured onto crushed ice, and the product (yield 60%) was recrystallized from chloroform–ethanol to give red needles, m p 162–165°, ν_{max}^{Nujol} 1725 cm^{-1} (COO and OAc)

Anal Calc for $C_{22}H_{24}N_6O_{10}S_2$ C, 44 3, H, 4 1, N, 14 1 Found C, 44 6, H, 4 3, N, 14 4

3-(L-threo-*Glycerol-1-yl*)-*1-phenyl-4,5-pyrazoledione 4*-(p-*sulfamylphenylhydrazone*) (**14**) — A solution of dehydro-L-ascorbic acid was treated with one molar equivalent of (*p*-sulfamylphenyl)hydrazine as for the preparation of **8**, whereby an amorphous product was obtained which upon treating its solution with phenylhydrazine, gave a product that, on dissolution in alkali and acidification, afforded an orange precipitate (yield 40%) that was recrystallized from ethanol, m p 300° (dec), ν_{max}^{Nujol} 1665 cm^{-1} (OCN)

Anal Calc for $C_{18}H_{19}N_5O_6S$ C, 49 9, H, 4 4, N, 16 2 Found C, 50 2 H, 4 7, N, 16 6

3-(L-threo-*Glycerol-1-yl*)-*1*-(p-*sulfamylphenyl*)-*4,5-pyrazolediione 4*-(p-*sulfamylphenylhydrazone*) (**15**) — A suspension of compound **9** (1 g) in M aqueous sodium hydroxide (50 mL) was heated until dissolution was complete, and then cooled, and acidified with acetic acid The orange product (yield 75%) that separated was filtered off, washed with water, and recrystallized from ethanol, m p 270–273°, ν_{max}^{Nujol} 3450 (OH) and 1675 cm^{-1} (OCN)

Anal Calc for $C_{18}H_{20}N_6O_8S_2$ C, 42 2, H, 3 9, N, 16 4, S, 12 5 Found C, 42 3, H. 3 6, N, 16 5, S, 12 2

1-(p-*Sulfamylphenyl*)-*3*-(L-threo-*1,2 3-tri*-O-*acetylglycerol-1-yl*)-*4,5-pyrazoledione 4*-(p-*sulfamylphenylhydrazone*) (**16**) — A solution of compound **15** (0 5 g) in dry pyridine (20 mL) was treated with acetic anhydride (5 mL), and kept overnight at room temperature The mixture was poured onto crushed ice, and the product (yield 75%) was filtered off, washed with water, dried, and recrystallized from ethanol, to give orange needles of **16**, m p 213°, ν_{max}^{Nujol} 1740 (OAc) and 1680 cm^{-1} (OCN)

TABLE I

MICROANALYTICAL AND INFRARED ABSORPTION DATA FOR L-*threo* 2,3-HEXODIULOSONO 1,4 LACTONE 2,3 BIS(*p*-SUBSTITUTED SULFAMYLPHENYLHYDRAZONES) (**10–12**)

Compound No	*M.p.* (*degrees*)	*Yield* (%)	*Molecular formula*	*Calculated* (%)				*Found* (%)				ν_{max}^{Nujol} (cm^{-1})
				C	*H*	*N*	*S*	*C*	*H*	*N*	*S*	
10	211–213	70	$C_{28}H_{28}N_{10}O_8S_2$	48.3	4.0	20.1	9.2	48.6	3.8	20.3	8.9	1750
11	217–220	75	$C_{30}H_{32}N_{10}O_8S_2$	49.7	4.4	19.3		49.4	4.2	19.5		1740
12	170–172	60	$C_{28}H_{28}N_{10}O_{10}S_2$	46.2	3.8	19.2		46.5	3.7	19.5		1760

Anal. Calc for $C_{24}H_{26}N_6O_{11}S_2$ C, 45 1, H, 4 1; N, 13 2, S, 10 0 Found C, 45 3, H, 4 3, N, 12 9, S, 9 6

1-(p-N-*Benzoylsulfamylphenyl*)-*3*-(L-threo-*tri*-O-*benzoylglycerol-1-yl*)-*4,5-pyrazoledione 4*-(p-N-*benzoylsulfamylphenylhydrazone*) (**17**) — A solution of compound **15** (0 5 g) in dry pyridine (20 mL) was treated with benzoyl chloride (2 mL), and kept overnight at room temperature The mixture was poured onto crushed ice, and the product (yield 50%) was filtered off, washed with water, dried, and recrystallized from ethanol, m p 160°; ν_{max}^{Nujol} 1720 (OBz) and 1660 cm^{-1} (OCN)

Anal Calc for $C_{53}H_{40}N_6O_{13}S_2$ C, 61 6. H, 3 9, N, 8 1, S, 6 2 Found C, 61 5; H, 4 2 N, 7 7, S, 6 1

3-Formyl-1-(p-*sulfamylphenyl*)-*4,5-pyrazoledione 4*-(p-*sulfamylphenylhydrazone*) (**18**) — A suspension of compound **15** (1 g) in a solution of sodium metaperiodate (0 9 g) in water (50 mL) was stirred for 2 h, and kept overnight at room temperature The product (yield 60%), after the usual processing, gave **18** as an amorphous powder, ν_{max}^{Nujol} 1700 (CHO) and 1660 cm^{-1} (OCN)

Anal Calc for $C_{16}H_{14}N_6O_6S_2$ C, 42 7, H, 3 1, N, 18 7 Found C, 43 1, H, 2 9, N, 19 0

Hydrazone derivatives of **18** — A solution of compound **18** (1 mmol) in *N,N*-dimethylformamide (20 mL) was treated with the respective hydrazine and boiled under reflux, to give compounds **20–25** (see Table II)

TABLE II

MICROANALYTICAL DATA FOR HYDRAZONE DERIVATIVES (**20–25**) OF **18**

Compound No	*M p (degrees)*	*Yield (%)*	*Molecular formula*	*Calculated (%)*			*Found (%)*		
				C	*H*	*N*	*C*	*H*	*N*
20	275	85	$C_{17}H_{17}N_9O_6S_2$	40 2	3 4	24 9	40 4	3 3	24 6
21	270	90	$C_{17}H_{17}N_9O_5S_3$	39 0	3 3	24 1	39 4	3 5	23 8
22	263	80	$C_{17}H_{18}N_{10}O_5S_2$	40 3	3 6	27 7	40 3	3 2	27 5
23	280	80	$C_{22}H_{20}N_8O_5S_2$	48 9	3 7	20 7	48 7	3 4	20 9
24	276	85	$C_{22}H_{21}N_9O_7S_3$	42 6	3 4	20 4	42 8	3 5	20 2
25	283	90	$C_{26}H_{23}N_{11}O_7S_3$	44 8	3 3	22 1	44 6	3 6	22 4

3,6-Anhydro-3-C-(p-*sulfamylphenylazo*)-L-xylo(*or* lyxo)-*2-hexulosono-1,4-lactone 2*-(p-*sulfamylphenylhydrazone*) (**19**) — A suspension of compound **9** (0 5 g) in a 10% solution of cupric chloride in ethanol (50 mL) was boiled under reflux for 15 min The product that separated out on cooling was filtered off, and recrystallized from ethanol, to give yellow needles of **19**, m p 195–197°, ν_{max}^{Nujol} 3400 (OH) and 1735 cm^{-1} (COO)

Anal Calc for $C_{18}H_{18}N_6O_8S_2$ C, 42 4, H, 3 7, N, 16 5, S, 12 5 Found C, 42 2, H, 4 0, N, 16 3, S, 12 2

3-(D-erythro-*Glycerol-1-yl*)-*1*-(p-*substituted-sulfamylphenyl*)-*4,5-pyrazoledione 4*-(p-*substituted-sulfamylphenylhydrazones*) (**28–31**) — A solution of dehydroiso-

ascorbic acid (**26**) in water was treated with two equivalents of the 4-substituted sulfamylphenylhydrazine (**2–6**) as for the preparation of **9**, and the resulting products were heated with M aqueous sodium hydroxide, followed by acidification, whereby orange products were obtained that were recrystallized from ethanol (see Table III)

TABLE III

MICROANALYTICAL AND INFRARED ABSORPTION DATA FOR 3-(D-*erythro*-GLYCEROL-1-YL)-1-(*p*-SUBSTITUTED-SULFAMYLPHENYL)-4,5-PYRAZOLEDIONE 4-[(*p*-SUBSTITUTED-SULFAMYLPHENYL)HYDRAZONES] (**28–31**)

Compound No	*M p (degrees)*	*Yield (%)*	*Molecular formula*	*Calculated (%)*			*Found (%)*			ν_{max}^{Nujol} *(cm⁻¹)*
				C	*H*	*N*	*C*	*H*	*N*	
28	267–268	65	$C_{18}H_{20}N_6O_8S_2$	42 2	3 9	16 4	42 0	4 4	16 8	1660
29	208–210	70	$C_{28}H_{28}N_{10}O_8S_2$	48 3	4 0	20 1	48 7	3 9	19 8	1665
30	>300	70	$C_{30}H_{32}N_{10}O_8S_2$	49 7	4 4	19 3	50 1	4 7	19 2	1660
31	>300	60	$C_{28}H_{28}N_{10}O_{10}S_2$	46 2	3 8	19 2	46 4	4 2	19 5	1660

*3-[(1-*p*-Sulfamylphenyl)hydrazono-*L*-threo-trihydroxybutyl]-2-quinoxalinone* (**33**) — A mixture of L-ascorbic acid (8 8 g) and *p*-benzoquinone (5 9 g) in ethanol (80 mL) was stirred for 90 min, the resulting mixture was treated with an ethanolic solution of *o*-phenylenediamine (5 9 g), and then diluted with water (250 mL) and heated for 5 min to give **32** An ethanolic solution of (*p*-sulfamylphenyl)hydrazine (9 5 g) was added, and the mixture was boiled for 5 min, whereby an orange product separated out (yield 85%) which was recrystallized from ethanol, m p 236–238° ν_{max}^{Nujol} 1665 cm^{-1} (OCN)

Anal Calc for $C_{18}H_{19}N_5O_6S$ C, 49 9 H 4 4, N 16 2 Found C, 49 6, H, 4 5, N, 15 9

3-{1-[(p-Sulfamylphenyl)hydrazono]glyoxal-1-yl}-2-quinoxalinone (**34**) — A suspension of **33** (0 4 g) in water (10 mL) was treated with a solution of sodium metaperiodate (1 1 g) in water (10 mL) The mixture was stirred for 2 h, and then kept overnight The product (yield 75%) was recrystallized from ethanol, to give orange needles, m p 303–305°, ν_{max}^{Nujol} 1680 (CHO) and 1665 cm^{-1} (OCN)

Anal Calc for $C_{16}H_{13}N_5O_4S$ C, 51 7, H, 3 5 N, 18 9 Found C, 51 5 H, 3 6, N, 18 9

3-(L-threo-Glycerol-1-yl)-1-(p-sulfamylphenyl)flavazole (**35**) — A suspension of compound **33** in 0 01M sodium hydroxide (25 mL) and a few drops of 1-butanol was boiled under reflux for 1 h The mixture was then cooled, and acidified with acetic acid, whereupon the product (yield 70%) separated out It was recrystallized from ethanol, m p 250°, ν_{max}^{Nujol} 3450 cm^{-1} (OH)

Anal Calc for $C_{18}H_{17}N_5O_5S$ C 52 0, H, 4 1 N, 16 9 Found C 52 4, H, 4 2, N, 17 1

3-Formyl-1-(p-sulfamylphenyl)flavazole (**36**) — A suspension of **35** in water was treated with sodium metaperiodate as for the preparation of **18** The product was recrystallized from ethanol, m p 323–325°, ν_{max}^{Nujol} 1695 cm^{-1} (CHO)

Anal Calc for $C_{16}H_{11}N_5O_3S$ C, 54 4, H, 3 1, N, 19 8 Found C, 54 1, H, 2 9, N, 20 1

REFERENCES

1 E S H El Ashry, M Nassr, and M Shoukry, *Pharmazie*, to be published
2 E S H El Ashry, I E El Kholy, and Y El Kilany *Carbohydr Res*, 64 (1978) 81–88
3 R G Shepherd, *Burger's Medicinal Chemistry*, 3rd edn, Wiley–Interscience New York 1970 pp 255–257
4 S L Ruskin, Brit Pat, 671,034 (1952), *Chem Abstr*, 47 (1953) 3345
5 S L Ruskin, U S Pat 2,606,903 (1952), *Chem Abstr*, 47 (1953) 5440
6 R Soliman, H Mokhtar, and E S H El Ashry, *Pharmazie* 33 (1978) in press
7 E S H El Ashry, and Y El Kilany, *Chem Ind (London)* (1976) 372–373
8 E S H El Ashry, *Carbohydr Res*, 33 (1974) 178–185
9 E S H El Ashry, Y El Kilany, and F Singab, *Carbohydr Res* 56 (1977) 93–104
10 E S H El Ashry M Nassr, and F Singab *Carbohydr Res* 56 (1977) 200–206
11 E S H El Ashry, I E El Kholy, and Y El Kilany *Carbohydr Res* 59 (1977) 417–426
12 E S H El Ashry, M M Abdel Rahman, S Mancy and Z M El Shafei *Acta Chim Acad Sci Hung* in press