A considerable effect of the previous oxidative treatment of the 2% Re/C and 2% Re/θ-Al_2O_3 catalysts with nitric and oxalic acids on cyclohexane dehydrogenation to benzene at 350 °C, v_{wt} = 0.5 h^{-1}, and atmospheric pressure has been shown previously.[6]

Unlike hydrogenation, dehydrogenation is a structure-sensitive reaction, and the genesis of the catalyst, including acid pretreatments, has a more pronounced effect on its occurrence.

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A simple method for preparing racemic dolichols from the polyprenols of pine needles (*Pinus silvestris*)

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A simple method for preparing racemic mammalian dolichols by a three-stage transformation of a native mixture of plant polyprenols has been developed.

Key words: (±)-dolichols, polyprenols, oxidation, polyprenal, dolichal, 1,4-reduction of enals, sodium dithionite.

2,3-Dihydroprenols, which belong to a group of dolichols (**1**), are participants in biosynthesis of glycoproteins of mammalian cells.[1] Investigation of these vitally important processes has been intensively developing recently. Hence, the search for preparative methods of the synthesis of alcohols of type **1** for preparation of biosynthetic intermediates and modified analogs on their basis has become timely (see, for example, Ref. 2). At the same time the isolation of dolichols **1** from natural sources is a labor-consuming procedure since their contents in eukaryotic cells, where they exist as mixtures of isoprenologs, is extremely low (thus, for example, only 0.2 g of dolichols was isolated from 5 kg of pig liver[3]).

At the present time a number of methods of total synthesis of compounds of type **1** are known; however, they are not acceptable as preparative methods since they include too many stages (see reviews[4,5] and papers cited therein). Partial synthesis of dolichols **1** by transformation of significantly more available allyl alcohols of plant origin, polyprenols **2**, looks more attractive.[6] Two approaches to accomplish such transformation are described.[5] One of them is based on lengthening of the oligoisoprene chain of polyprenols **2** by a saturated unit using synthetic C_5-blocks specially prepared for this purpose. The alternative most effective method includes catalytic hydrogenation of allyl alcohols of type **2** or their derivatives. However, the disadvantage of this approach is the necessity of using very expensive catalysts to guarantee a high selectivity of hydrogenation of the terminal double bond in oligoolefins **2**.

In this paper we report a new method for the synthesis of a mixture of (±)-dolichols **1'** (Scheme 1) based on

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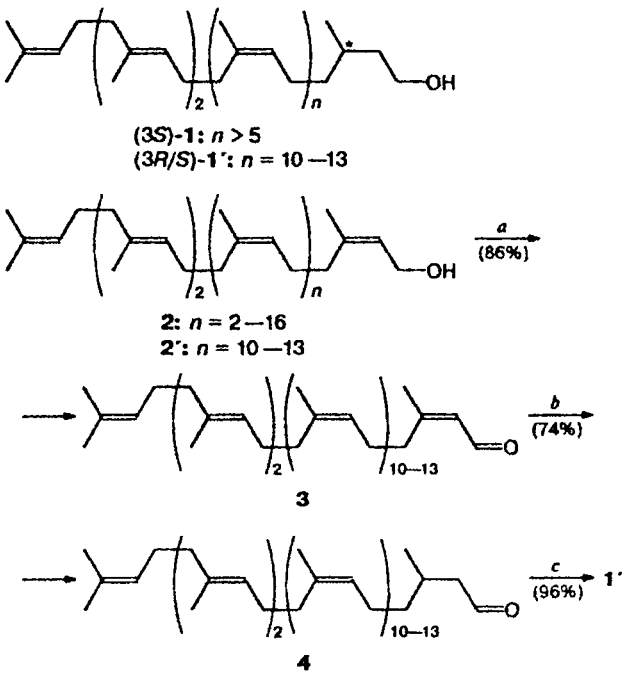
transformation of polyprenols of pine needles (*Pinus silvestris*) **2'** [6,7] using cheap and accessible reagents. This method is based on pre-oxidation of alcohols **2'** with MnO_2 to give enals **3** *; this ensures chemoselectivity of saturation of the terminal double bond during subsequent 1,4-reduction of enals **3** with sodium dithionite ($Na_2S_2O_4$) under conditions recommended[8] for similar transformations. Hydride reduction of aldehydes **4** smoothly leads to a mixture of isoprenologs **1'**; their total yield from polyprenols **2'** is ~61%.

Scheme 1



Reagents and conditions: *a*. MnO_2, CH_2Cl_2, 20 °C; *b*. $Na_2S_2O_4/Na_2CO_3/Bu^n_4N^+Br^-$, PhH, H_2O, reflux; *c*. $NaBH_4$, THF—H_2O, 20 °C.

Novel compounds **3** and **4** were purified by flash-chromatography on SiO_2 (Kieselgel 60, Merck). Their structure was confirmed by the data of spectral and elemental analyses. According to HPLC data (Fig. 1), the ratio of corresponding isoprenologs in the resulting mixture of (±)-dolichols **1'** is practically the same as in that of the starting polyprenols **2'**. The ^1H NMR spectrum of a mixture of (±)-dolichols **1'** contains a set of signals characteristic of the compounds of this class (see, for example, Ref. 4).

* It should be noted that oxidation of allylic alcohols **2'** with pyridinium chlorochromate (CH_2Cl_2, 20 °C) gives a mixture of *Z*- and *E*-enals in the ratio ~2 : 1, as follows from the presence of additional signals of CHO protons of *E*-isomers (δ 10.01, d, J = 10.4 Hz) with corresponding integral intensities in the ^1H NMR spectrum.

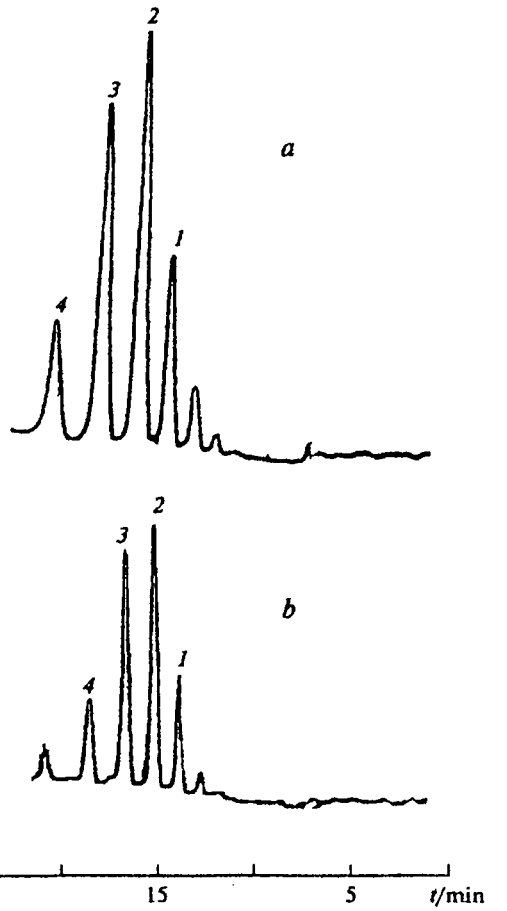


Fig. 1. HPLC data: retention times and composition of isoprenologs **2'** (*a*) and **1'** (*b*): n = 10 (*1*); 11 (*2*); 12 (*3*); and 13 (*4*).

Experimental

IR spectra were recorded with a Specord M-80 spectrometer for solutions in $CHCl_3$. The UV spectrum was recorded with a Specord UV-VIS spectrophotometer. ^1H NMR spectra were recorded with a Bruker WM-250 spectrometer for solutions in $CDCl_3$. R_f values are given for a fixed layer of SiO_2 (Silufol) with hexane—ether (4 : 1, v/v) as a developer. HPLC was performed on a column packed with Separon SGX C-18 (5 μm, 150×3.3 mm) using acetone—acetonitrile (4 : 1, v/v, flow rate 0.5 mL min^{-1}) as an eluent and a refractometer as detector.

A sample of polyprenols **2'** with the ratio of isoprenologs $C_{70}H_{112}O$: $C_{75}H_{120}O$: $C_{80}H_{128}O$: $C_{85}H_{136}O$ ≈ 6 : 13 : 14 : 7 (*cf.* Refs. 6 and 7) was kindly supplied by V. I. Roshchin (Saint Petersburg Academy of Forestry Engineering). Components of the mixture were identified using HPLC under conditions described above, by comparison with authentic samples of individual isoprenologs.

Polyprenals (3). To a solution of prenols **2'** (1 g, ~0.93 mmol) in 10 mL of CH_2Cl_2 was added MnO_2 (1.2 g, 13.8 mmol). The resulting suspension was stirred for 4 h at 20 °C and then filtered. The filtrate was concentrated under reduced pressure, the residue was chromatographed on 30 g of

SiO_2. Gradient elution with the system hexane → hexane—Et_2O (9 : 1) gave a mixture of aldehydes **3** (0.86 g, 86%) as a colorless oil with R_f 0.58. IR, ν/cm^{-1}: 1680 (C=O). UV (hexane), λ_{max}/nm (ε): 204 (100000), 233 (12000), 290 (357). ^1H NMR, δ: 1.61 (br.s, *cis*-Me); 1.69 (br.s, *trans*-Me); 1.94 (br.s, MeC-3); 1.9—2.1 (m, CH_2); 2.59 (br.t, HC-4, J = 8.2 Hz); 5.15 (m, HC=); 5.90 (br.d, HC-2, J = 10.4 Hz); 9.92 (d, HCO, J = 10.4 Hz). Found (%): C, 86.62; H, 12.00. $C_{70}H_{112}O$, $C_{75}H_{120}O$, $C_{80}H_{128}O$, $C_{85}H_{136}O$. Calculated, respectively (%): C, 86.71, 86.80, 86.89, 86.96; H, 11.64, 11.66, 11.67 11.68.

Aldehydes (4). To a vigorously stirred emulsion containing prenals **3** (0.45 g, ~0.42 mmol), $NaHCO_3$ (0.68 g, 8.1 mmol), and $Bu^n_4N^+Br^-$ (50 mg, 0.16 mmol) in 4 mL of PhH and 4 mL of H_2O was added portionwise $Na_2S_2O_4$ (0.8 g, 4.6 mmol) for 2 h at 80 °C (Ar); the reaction mixture was kept for 30 min and cooled to 20 °C. The water layer was separated and extracted with benzene. The combined organic fraction was washed with saturated aqueous NH_4Cl and H_2O, dried (Na_2SO_4), and concentrated under reduced pressure; the residue (0.5 g) was chromatographed on 15 g of SiO_2. Gradient elution with the system hexane → hexane—Et_2O (9 : 1) gave a mixture of aldehydes **4** (0.33 g, 74%) as a colorless oil with R_f 0.67. IR, ν/cm^{-1}: 1725 (C=O). ^1H NMR, δ: 0.98 (d, MeC-3, J = 8.1 Hz); 1.2—1.6 (m, HC-3, HC-4); 1.61 (br.s, *cis*-Me); 1.70 (br.s, *trans*-Me); 1.9—2.2 (m, CH_2); 2.2—2.5 (m, HC-2); 5.15 (m, HC=); 9.76 (t, HCO, J = 4.4 Hz). Found (%): C, 86.42; H, 11.88. $C_{70}H_{114}O$, $C_{75}H_{122}O$, $C_{80}H_{130}O$, $C_{85}H_{138}O$. Calculated, respectively (%): C, 86.53, 86.63, 86.73, 86.81; H, 11.82, 11.83, 11.83, 11.83.

(±)-Dolichols (1'). A solution of a mixture of aldehydes **4** (0.67 g, ~0.63 mmol) and $NaBH_4$ (50 mg, 1.32 mmol) in 5 mL of aqueous THF (~10% H_2O) was stirred for 1 h at 20 °C, then diluted with 20 mL of hexane, and washed with saturated aqueous NH_4Cl. The organic layer was separated, dried (Na_2SO_4), and concentrated under reduce pressure; the residue (0.7 g) was chromatographed on 20 g of SiO_2. Gradient elution with the system hexane → hexane—Et_2O (4 : 1) gave a mixture of (±)-dolichols **1'** (0.64 g, 96%) as a colorless oil with R_f 0.33. ^1H NMR, δ: 0.92 (d, MeC-3, J = 7.5 Hz); 1.15—1.55 (m, HC-2, HC-3, HC-4); 1.62 (br.s, *cis*-Me); 1.71 (br.s, *trans*-Me); 1.95—2.15 (m, CH_2); 3.69 (m, HC-2); 5.15 (m, HC=).

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