

Efavirenz, emtricitabine and tenofovir disoproxil tablets (Efavirenzi, emtricitabini et tenofoviri disoproxili compressi)

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Category. Antiretroviral (Non-nucleoside/Nucleoside/Nucleotide Reverse Transcriptase Inhibitors).**Storage.** Efavirenz, emtricitabine and tenofovir disoproxil tablets should be kept in a tightly closed container.**Additional information.** Strength in the current WHO Model List of Essential Medicines: 600 mg Efavirenz, 200 mg Emtricitabine and 300 mg Tenofovir disoproxil fumarate.**Requirements**Comply with the monograph for [Tablets](#).**Definition.** Efavirenz, emtricitabine and tenofovir disoproxil tablets contain Efavirenz, Emtricitabine and Tenofovir disoproxil fumarate. They contain not less than 90.0% and not more than 110.0% of the amount of efavirenz ($C_{14}H_9ClF_3NO_2$), emtricitabine ($C_8H_{10}FN_3O_3S$) and tenofovir disoproxil fumarate ($C_{19}H_{30}N_5O_{10}P, C_4H_4O_4$) stated on the label.**Manufacture.** The manufacturing process and the product packaging are designed and controlled so as to minimize the moisture content of the tablets. They ensure that, if tested, the tablets would comply with a water content limit of not more than 50 mg/g when determined as described under [2.8 Determination of water by the Karl Fischer method](#), Method A, using about 0.5 g of the powdered tablets.**Identity tests**

-Either tests A and B or test C may be applied.

A. Carry out test A.1 or, where UV detection is not available, test A.2.

A.1 Carry out the test as described under [1.14.1 Chromatography, Thin-layer chromatography](#) using silica gel R6 as the coating substance and a mixture of 90 volumes of dichloromethane R, 10 volumes of methanol R and 3 volumes of glacial acetic acid R as the mobile phase. Apply separately to the plate 5 μ L of each of the following four solutions in methanol R. For solution (A) disperse a quantity of the powdered tablets to obtain a concentration of 5 mg of Emtricitabine per mL, filter and use the filtrate. For solution (B) use 5 mg of emtricitabine RS per mL. For solution (C) use 7.5 mg of tenofovir disoproxil fumarate RS per mL. For solution (D) use 15 mg of efavirenz RS per mL. After removing the plate from the chromatographic chamber allow it to dry exhaustively in air or in a current of air. Examine the chromatogram in ultraviolet light (254 nm).

The three principal spots obtained with solution A correspond in position, appearance and intensity with those obtained with solutions B, C and D.

A.2 Carry out the test as described under [1.14.1 Chromatography, Thin-layer chromatography](#) using the conditions described above under test A.1 but using silica gel R5 as the coating substance. Stain the plate with iodine vapour and examine the chromatogram in daylight.

The three principal spots obtained with solution A correspond in position, appearance and intensity with those obtained with solutions B, C and D.

B. Carry out test B.1. or, where UV detection is not available, test B.2.

B.1 Carry out the test as described under [1.14.1 Chromatography, Thin-layer chromatography](#) using silica gel R6 as the coating substance and a mixture of 50 volumes of heptane R, 30 volumes of glacial acetic acid R and 20 volumes of dichloromethane R as the mobile phase. Apply separately to the plate 5 μ L of each of the following two solutions in ethanol R. For solution (A) disperse a quantity of the powdered tablets to obtain a concentration of 10 mg of Tenofovir disoproxil fumarate per mL, filter and use the filtrate. For solution (B) use 2 mg of fumaric acid R per mL. Develop the plate in an unsaturated tank over a path of 10 cm.

After removing the plate from the chromatographic chamber allow it to dry exhaustively in air or in a current of air. Examine the chromatogram in ultraviolet light (254 nm).

One of the spots obtained with solution (A) corresponds in position, appearance and intensity with that obtained with solution B.

B.2 Carry out the test as described under [1.14.1 Chromatography, Thin-layer chromatography](#) using the conditions described above under test B.1 but using silica gel R5 as the coating substance. Spray lightly with a 16 g/L solution of potassium permanganate R and examine the chromatogram in daylight.

One of the spots obtained with solution A corresponds in position, appearance and intensity with that obtained

with solution B.

C. See the test described under "Assay". The retention times of the principal peaks due to efavirenz, emtricitabine, tenofovir disoproxil and fumarate in the chromatogram obtained with solution (1) are similar to those in the chromatogram obtained with solution (2).

Dissolution

Carry out the test as described under [5.5 Dissolution test for solid oral dosage forms](#) using as the dissolution medium, 1000 mL of a 2% solution of sodium dodecyl sulfate R and rotating the paddle at 100 revolutions per minute. At 30 minutes withdraw a sample of 10 mL of the medium through an in-line filter. Allow the filtered sample to cool to room temperature and dilute if necessary (solution (1)). Prepare solution (2) using 0.60 mg of efavirenz RS, 0.20 mg of emtricitabine RS and 0.30 mg of tenofovir disoproxil fumarate RS per mL of dissolution medium. Determine the content of efavirenz ($C_{14}H_9ClF_3NO_2$), emtricitabine ($C_8H_{10}FN_3O_3S$) and tenofovir disoproxil fumarate ($C_{19}H_{30}N_5O_{10}P,C_4H_4O_4$) as described under "Assay" with the following modification: analyse solution (1) and solution (2) at room temperature without delay. Do not refrigerate the solutions and do not use an injector with cooling.

For each of the six tablets tested calculate the total amount of efavirenz ($C_{14}H_9ClF_3NO_2$), emtricitabine ($C_8H_{10}FN_3O_3S$) and tenofovir disoproxil fumarate ($C_{19}H_{30}N_5O_{10}P,C_4H_4O_4$) in the medium from the results obtained, using the declared content of efavirenz ($C_{14}H_9ClF_3NO_2$) in efavirenz RS, the declared content of emtricitabine ($C_8H_{10}FN_3O_3S$) in emtricitabine RS and the declared content of tenofovir disoproxil fumarate ($C_{19}H_{30}N_5O_{10}P,C_4H_4O_4$) in tenofovir disoproxil fumarate RS. For each substance the amount in solution for each tablet is not less than 80% of the amount stated on the label. If the amount obtained for one of the six tablets is less than 80% repeat the test using a further six tablets; the average amount for all 12 tablets tested is not less than 75% and no tablet releases less than 60%.

Tenofovir monosoproxil.^[1] Carry out the test as described under [1.14.1 Chromatography, High-performance liquid chromatography](#) using the conditions given under "Assay".

^[1] The structure of tenofovir monosoproxil is given in the monograph on Tenofovir disoproxil fumarate.

After preparation keep the solutions at about 6 °C or use an injector with cooling.

Prepare the following solutions using a mixture of 50 volumes of methanol R and 50 volumes of water R as a diluent. For solution (1) disperse a quantity of the powdered tablets containing about 100.0 mg of Tenofovir disoproxil fumarate in 100 mL of the diluent and filter. For solution (2) dilute a suitable volume of solution (1) to obtain a concentration of 5 µg of Tenofovir disoproxil fumarate per mL. For solution (3) heat carefully 1 mg of tenofovir disoproxil fumarate RS per mL of water R in a boiling water-bath for 20 minutes.

Operate with a flow rate of 1.0 mL per minute. As a detector use an ultraviolet spectrophotometer set at a wavelength of 280 nm.

Maintain the column temperature at 35 °C.

Inject 20 µL of solution (3). The peak due to tenofovir monosoproxil elutes at a relative retention of about 0.9 with reference to tenofovir disoproxil (retention time about 18 minutes). The test is not valid unless the resolution between these peaks is at least 5.

Inject separately 20 µL each of solutions (1) and (2).

In the chromatogram obtained with solution (1) the area of any peak due to tenofovir monosoproxil is not greater than 10 times the area of the principal peak obtained with solution (2) (5.0%).

Assay

Carry out the test as described under [1.14.1 Chromatography, High-performance liquid chromatography](#) using a stainless steel column (25 cm x 4.6 mm) packed with base-deactivated particles of silica gel, the surface of which has been modified with chemically-bonded octadecylsilyl groups (5 µm).

The mobile phases for gradient elution consist of a mixture of Mobile phase A and Mobile phase B using the following conditions:

mobile phase A: 5 volumes of potassium dihydrogen phosphate (27.2 g/l) TS and 95 volumes of water R;

mobile phase B: 70 volumes of acetonitrile R, 5 volumes of potassium dihydrogen phosphate (27.2 g/l) TS and 25 volumes of water R.

Time (min)	Mobile phase A (% v/v)	Mobile phase B (% v/v)	Comments
0–9	93	7	Isocratic
9–15	93–0	7–100	Linear gradient
15–19	0	100	Isocratic

19=19.1	0=93	100=7	Return to initial composition
19.1=30	93	7	Re-equilibration

After preparation keep the solutions at about 2 to 8 °C or use an injector with cooling.

Prepare the following solutions using a mixture of 50 volumes of methanol R and 50 volumes of water R as a diluent. For solution (1) weigh and powder 20 tablets. Disperse a quantity of the powder containing about 100.0 mg of Tenofovir disoproxil fumarate in 100.0 mL of the diluent and filter. Dilute 10.0 mL of this solution to 100.0 mL with the diluent. For solution (2) use 0.2 mg of efavirenz RS, 0.1 mg of tenofovir disoproxil fumarate RS and 66.7 µg of emtricitabine RS per mL of diluent. For solution (3) use 0.02 mg of fumaric acid R per mL of water R.

If necessary adapt the concentration of solution (2) according to the ratio of Efavirenz, Emtricitabine and Tenofovir disoproxil fumarate in the tablets.

Operate with a flow rate of 1.0 mL per minute. As a detector use an ultraviolet spectrophotometer set at a wavelength of 280 nm.

Maintain the column temperature at 35 °C.

Inject separately 20 µL each of solutions (1), (2) and (3).

The chromatograms obtained with solutions (1) and (2) show four principal peaks at the following retention times: fumarate (about 2.5 minutes); emtricitabine (about 9 minutes); tenofovir disoproxil (about 18 minutes); and efavirenz (about 22 minutes). The test is not valid unless the resolution between these peaks is at least 5.

Calculate the content of efavirenz ($C_{14}H_9ClF_3NO_2$), emtricitabine ($C_8H_{10}FN_3O_3S$) and tenofovir disoproxil fumarate ($C_{19}H_{30}N_5O_{10}P,C_4H_4O_4$) in the tablets using the declared content of efavirenz ($C_{14}H_9ClF_3NO_2$) in efavirenz RS, the declared content of emtricitabine ($C_8H_{10}FN_3O_3S$) in emtricitabine RS and the declared content of tenofovir disoproxil fumarate ($C_{19}H_{30}N_5O_{10}P,C_4H_4O_4$) in tenofovir disoproxil fumarate RS.