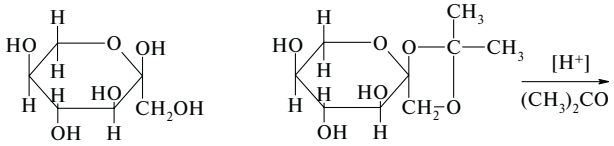
# SYNTHESIS OF DIACETONE-*L*-SORBOSE

**M. A. Nadtochii,[1] L. E. Burova,[1] I. B. Vasil'eva,[1] and T. A. Melent'eva[1]**

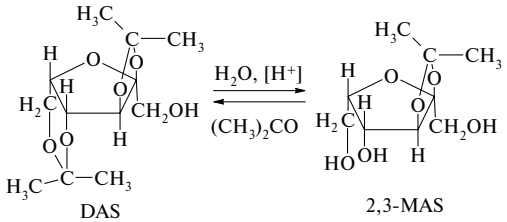
Translated from Khimiko-Farmatsevticheskii Zhurnal, Vol. 35, No. 4, pp. 52 – 53, April, 2001.

*Original article submitted June 8, 1990.*

Diacetone-*L*-sorbose (DAS) is an intermediate product in the synthesis of ascorbic acid. DAS is obtained by acetonating *L*-sorbose in the presence of a catalyst. Possible catalysts are oleum, zinc chloride, copper sulfate, sulfonic acids, and ion exchange resins. In addition to DAS, the process of sorbose acetonation yields 1,2- and 2,3-monoacetonesorbose (1,2- and 2,3-MAS) [1]:




L-Sorbose 1,2-O-Isopropylidene-α-*L*-sorbopyranose




DAS 2,3-MAS

The acetonation process is accompanied by a side reaction whereby the condensation of two acetone molecules yields mesityl oxide. To the present, factors affecting the course of the acetonation reaction and the DAS yield are incompletely clear. Since the synthesis of DAS in domestic plants is catalyzed by oleum, we have also studied the process in the presence of this catalyst.

In the first stage, we studied the effect of temperature on the sorbose acetonation reaction. The experiments were performed with non-comminuted sorbose (particle size, 0.25 mm) because many of the domestic plants use this material without additional grinding. It was established that the optimum temperature conditions are the following: the process is initiated at – 15°C, after which the temperature is gradually increased to 25°C. At this temperature sorbose dissolves in acetone during 2 – 3 h. Finally, the reaction mass is cooled down to – 15°C again and held at this temperature for 1 h. Under these conditions, the yield of DAS reaches 81% and the tar formation decreases to 7% (Table 1). The same process using additionally ground sorbose (with a particle size below 0.25 mm) yields 86% of DAS and 5% of tar.

A no less important factor is the presence of water which forms during the acetonation reaction and can be additionally brought in with the initial reagents. In the presence of water, the yield of DAS may significantly decrease as a result of hydrolysis. This circumstance imposes an important requirement on the reagents: the water content must not exceed 0.1% in sorbose and 0.3% in acetone, and the oleum concentration must be not less than 18% $SO_3$. The amount of oleum, which is added for binding water formed in the course of acetonation, is very important: an increase in the oleum leads to intensification of the process, whereas a decrease favors DAS hydrolysis by the unbound water.

It was found that the yield of DAS increases with the relative content of acetone (Table 2). An increase in the acetone to sorbose (A/S, v/w) ratio from 12 : 1 to 15 : 1 leads to a 7% increase in the DAS yield. However, this implies an increase in the volume of acetone to be regenerated. The influence of the A/S ratio on the acetonation process was studied under the optimum (–15°C, +25°C) temperature conditions. The optimum A/S ratio in this regime is 12 : 1.

**TABLE 1.** Effect of Temperature on the *L*-Sorbose Acetonation Process

| Temperature regime, °C | Process duration, h | DAS yield, % | Tar yield, % |
|---|---|---|---|
| 30 | 0.8 | 54.0 | 29.2 |
| 40 | 0.7 | 30.2 | 35.8 |
| 30 | 2.5 | 73.6 | 13.4 |
| 20 | 2.5 | 70.0 | 17.0 |
| – 15, + 25 | 1 – 3 | 77.5 | 10.8 |
| – 15, + 25 | 1 – 1.5 | 81.0 | 7.2 |
| – 15, + 25 | 1 – 2.5 | 80.2 | 7.8 |

**Note**: Sorbose/acetone/oleum ratio, 1 : 12 : 0.5.

[1] State Research Institute of Vitamins, State Unitary Enterprise, Moscow, Russia.

**TABLE 2.** Effect of the Acetone to Sorbose (A/S) Ratio of the Diacetone-*L*-sorbose (DAS) Yield

| A/S, ml/g | Acetonation temperature, °C | Process duration, min | DAS yield, % |
|---|---|---|---|
| 10 : 1 | – 15, + 25 | 150 | 78.8 |
| 11 : 1 | – 15, + 25 | 150 | 79.3 |
| 12 : 1 | – 15, + 25 | 120 | 80.5 |
| 13 : 1 | – 15, + 25 | 120 | 81.5 |
| 15 : 1 | – 15, + 25 | 100 | 87.1 |

Since the yield of DAS is accompanied by the formation of monoacetonesorbose, it is necessary to separate these products. There are several possible methods to separate mono- and diacetonesorbose. The first is to extract DAS with the aid of an organic solvent such as ether, chloroform, benzene, toluene, or trichloroethylene. Another possibility is to salt out DAS with an alkali. We performed a special comparative experiment on the separation of DAS and MAS by the extraction and salting-out methods (Table 3). The initial solution was the neutralized acetone solution obtained from the Shchelkovo Vitamin Plant. The content of DAS and MAS in the residues obtained upon evaporating the extracts in vacuum was determined by gas chromatography.

As is seen from Table 3, the content of DAS in the product obtained by extraction with an organic solvent is 92 – 96% and the degree of extraction is 96 – 99%. The product obtained by salting out with an alkali solution contains 83 – 84% of DAS and only 94% of DAS is isolated after an 18-h treatment.

As a result, we selected the following procedure for the exaction of DAS. First, the reaction mass is neutralized by an 8% alkali solution. Upon separation of the layers, acetone and mesityl oxide are distilled off from the water–acetone phase and the residue is dissolved in water. Finally, DAS is extracted with an organic solvent.

Thus, we have established that the decisive factors in the process of *L*-sorbose acetonation are the temperature regime and the acetone-to-sorbose ratio. Optimum conditions for the isolation of diacetone-*L*-sorbose were determined.

**TABLE 3.** Diacetone-*L*-sorbose Isolation under Various Conditions

| Extractant, salting-out reagent | Procedure | DAS content, % | Degree of DAS isolation, % |
|---|---|---|---|
| Chloroform | Double extraction (2 : 1) | 94.66 | 99.0 |
| Toluene | Double extraction (2 : 1) | 92.14 | 96.5 |
| Trichloroethylene | Double extraction (2 : 1) | 96.0 | 96.3 |
| 44% aqueous NaOH | Salting-out for 2 h | 83.2 | 86.6 |
| 44% aqueous NaOH | Salting-out for 18 h | 84.33 | 94.0 |

## EXPERIMENTAL PART

To 275 ml of acetone at –15°C was added dropwise 15 ml of oleum containing 18% $SO_3$. To this solution was added 25 g of sorbose and the mixture was stirred and heated to 25°C, after which stirring is continued until compete dissolution of sorbose. After stirring for about 2 h, the reaction mass is cooled to –15°C and kept at this temperature for 1 h. Then the solution is neutralized with an 8% sodium hydroxide solution and allowed to stand until layer separation. The aqueous sodium sulfate solution is used to crystallize sodium sulfate. The aqueous-acetone solution containing DAS and MAS is treated in a film-rotary evaporator to distill off acetone and then mesityl oxide. According to the gas chromatography (GC) data, the residue (30.66 g) contains 28.45 g DAS (yield, 81.3%), no 1,2-MAS, and traces of 2,3-MAS. The sold residue is dissolved in 40 ml water and extracted (2 × 140 ml) with trichloroethylene. Then the solvent is distilled off to leave a residue (26.74 g) containing (GC data) 26.10 g of DAS; DAS yield upon extraction, 96.3%.

## REFERENCES

1. V. M. Berezovskii, *Vitamin Chemistry* [in Russian], Pishchevaya Prom-st, Moscow (1973), p. 39.