9.1 Synonyms

IUPAC: Potassium nitrate


9.2 History

Nitrate has been used for centuries to pickle meat and as an additive for fish and cheese. No one knows for certain who first employed nitrate in food preservation. According to the literature, the Dutchman, Gillis Beukel (d. 1397), was the first to use nitrate for the preservation of fish, and the word “pickle” is said to derive from his name, but this has not been substantiated. Beukel may possibly have worked only with common salt and been unfamiliar with nitrate, like others who had practiced pickling even earlier (Binkerd and Kolari 1975). Nitrate was definitely known by about 1500, as it is mentioned by Sebastian Brandt (as saltpeter) in his satirical poem “The Ship of Fools” (see Sect. 4.1).

Despite more recent revelations concerning the action of nitrites, nitrates remain important to this day, especially in the treatment of meat in large cuts, although there is evidence that its use in food preservation is on the decline.

9.3 Commercially Available Forms

Sodium and potassium nitrate (or sodium and potassium saltpeter, as they may still occasionally be known) are used, either pure or in admixtures with common salt and other substances, as a curing salt.

9.4 Properties

$\text{NaNO}_3$, molar mass 84.99, $\text{KNO}_3$, molar mass 101.11, white crystalline powders which melt at 311 °C ($\text{NaNO}_3$) and 337 °C ($\text{KNO}_3$). Sodium nitrate is hygroscopic. At room temperature, 100 g water will dissolve about 90 g $\text{NaNO}_3$ and about 37 g $\text{KNO}_3$. Both nitrates are only very sparingly soluble in alcohol.
9.5 Analysis

In the detection and determination of nitrates it should be borne in mind that most reactions of the nitrate ion are affected by the presence of nitrite ions, which are frequently found alongside nitrates. This disturbing effect is prevented by removing the nitrite beforehand, e.g. by reacting it with urea in an acid solution or eliminating it with amidosulfonic acid. Besides the conventional color reactions, most of which are the result of reducing the nitrate to nitrite and reacting the nitrite with sulfanilic acid or \( \alpha \)-naphthylamine, for example, ion chromatography can be used to identify and quantify nitrates and nitrites in a single run (Stein et al. 1988).

9.6 Production

Sodium nitrate in pure form is obtained by passing the nitrous gases from ammonia combustion through caustic soda or soda solution. Potassium nitrate is produced by reacting potassium carbonate or caustic potash with nitric acid, or from potassium chloride and nitric acid in the presence of oxygen.

9.7 Health Aspects

9.7.1 Acute Toxicity

The LD\(_{50}\) of sodium nitrate for rats is in the region of 3 – 7 g/kg bodyweight. Nitrates appear to be considerably more toxic to larger animals. The lethal dosage quoted for humans is 30 – 35 g/kg bodyweight (Battelle 1972) but, even in substantially smaller doses than this, potassium nitrate causes local intestinal irritation and diarrhea owing to dehydration in the intestine. Potassium nitrate is more toxic than sodium nitrate (Wirth et al. 1985).

9.7.2 Subchronic Toxicity

There has been a lack of systematic feeding experiments relating to the use of nitrates as food additives. Relevant data available is concerned mainly with the intake of nitrates via drinking water or vegetable feed consumed by livestock. Although as little as 100 mg potassium nitrate per liter drinking water causes an increase in the methemoglobin formation in livestock over a 5-week period, other data show that some 2% nitrate, relative to grass feed, has no untoward influence on sheep (Battelle 1972).

In concentrations of up to 400 mg/kg bodyweight, nitrates have no teratogenic action (Battelle 1972).