pH moči

The kidneys are the organ where the acid-base balance is adjusted by eliminating (or retaining) H + . The pH in the glomerular filtrate is the same as in plasma. As it passes through the renal tubular system, urinary acidification occurs.

The concentration of free protons in the urine is negligible compared to other ions; we can therefore say that H + is eliminated by the kidneys in two forms:

- bound to the anions present, eg to phosphates (conversion of hydrogen phosphate to dihydrogen phosphate)

  $$H+ + HPO42- \rightarrow H2PO4-$$

  or to the anions of certain organic acids. This proportion is called the so-called titratable acidity, which under normal conditions is 10-30 mmol / 24 hours. It can be determined by titration with sodium hydroxide.

- as the ammonium cation, which is the most important system.

  $$H + + NH\ 3 \rightarrow NH\ 4 +$$

  The amount of NH 4 + excreted in the urine is between 30-50 mmol / 24 hours.

Urine pH depends on:

on the composition of the diet
: In a healthy person, urinary pH is most affected by the composition of the diet. Lactovegetarian diet causes alkalization of urine. In contrast, a diet rich in protein (meat) is accompanied by acidification.

on the state of acid-base equilibrium
: Under pathological circumstances, urine pH reflects acid-base imbalances. Changes in urine pH are a manifestation of the compensatory and corrective activity of the kidneys. Aciduria is the result of correction of metabolic and correction of respiratory acidosis, alkaliuria is at the beginning of compensation of respiratory and correction of metabolic alkalosis. However, the excretion of acidic urine in acidosis and alkaline urination in alkalosis only applies to mild disorders and well-functioning kidneys. The current finding of aciduria and ketonuria indicates starvation. A combination of aciduria, ketonuria and glycosuria is common in the decompensation of diabetes mellitus.

The most common factors affecting urine pH

Acidic pH	Alkaline pH
protein diet	vegetarian food
protein diet	vegetarian food
dehydration	renal tubular acidosis
diabetická ketoacidóza	respiratory and metabolic alkalosis
metabolic and respiratory acidosis	bacterial urinary tract infections
starvation	

Permanently **alkaline** urine pH may indicate:

- **Infection** of the kidneys or urinary tract with urease-producing bacteria. Enzymatic hydrolysis of urea produces ammonia, which alkalizes the urine. The situation is similar for bacterially contaminated urine, in which the bacteria multiplied during a longer period of storage.

  $$H\ 2\ N\text{-}CO\text{-}NH\ 2 + H\ 2\ O2NH\ 3 + CO\ 2$$
  $$NH3 + H2O \rightarrow NH4+ + OH-$$

- **Distal renal tubular acidosis** , which is a disorder of the renal tubular cells characterized by the inability of the distal tubule to secrete H + .

The main benefit of urine pH testing is in the **diagnosis and treatment of urinary tract infections and urolithiasis** . Permanent variations in urine pH may be one of the factors contributing to the formation of urinary stones.

- Calcium oxalate stones are common in **acidic urine**. At acidic pH, uric acid stones are also easily formed. Alkalization of urine above pH 7.0 can, under favorable circumstances, lead to the slow dissolution of uric acid

stones and the prevention of their formation. Cystine also precipitates more easily in acidic urine.
- Phosphates are poorly soluble in **alkaline** urine and at pH above 7 ammonium magnesium phosphate (struvite - $MgNH_4PO_4 \cdot 6H_2O$) and a mixture of phosphate and calcium carbonate ["carbonate capatite" - $Ca_{10}(PO_4CO_3OH)_3(OH)_3$].

Determination of urinary pH

Urine pH should always be tested in **fresh** urine. It is usually determined by **diagnostic strips** . Accurate pH determination can be performed with a pH meter .

The physiological pH of urine is in the range of 5.0–6.5, the extreme values are 4.5–8.0. Extreme values in the acidic or alkaline range suggest that urine collection instructions are not followed.

Examination of renal acidification

The basic examination to assess the acidifying activity of the kidneys is to examine **the pH of a morning urine sample** . The pH determination must be performed immediately and the use of a pH meter is recommended . In a healthy adult, the pH of the morning sample is less than 6.0. At higher values, there is a suspicion of impaired acidification, and if there are no contraindications (eg significant reduction in renal function), it is possible to perform an **acidification test** after NH_4Cl or $CaCl_2$(in patients with hepatic impairment). The patient is given ammonium chloride (2 mmol per kg body weight). 3 hours after ingestion of the test substance, urine is collected at 3-hour intervals and immediately after collection, the acidity of the urine samples is measured with a pH meter. With intact renal acidification, urine pH should fall below 5.5.

Acidifying ability is impaired in patients with renal tubular acidosis of the distal type.

In the case of an ambiguous result of the acidification test, the alkalizing ability of the kidneys after oral or intravenous exposure to sodium bicarbonate is examined.