
**Literatur**

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**Short Communication: „Isotonic“: What does it stand for?**

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**Introduction**
During the last decade numerous studies have been published on aspects of oral rehydration for sportsmen and women. Many of these studies have dealt with the influence of osmotic pressure of the rehydration drink on gastric emptying and intestinal absorption. The terms osmolality and osmolarity are often used. Yet, these terms have different meanings and are not exclusively exchangeable. The term isotonicity is often used to express that a specific drink has the same osmotic pressure as the reference fluid, e.g. blood. Yet, having the same osmotic pressure does not necessarily mean being isotonic in a biological system.

This article describes these terms and gives reference to actual lexis and scientific literature.

**Isotonic or isosmotic?**
In literature both terms are generally described as „having the same osmotic pressure“ as reference fluid. Isotonicity is the property of being isotonic. However, although two solutions may have the same osmotic pressure as determined in vitro by measuring freezing point depression, it does not necessarily mean that these two solutions behave equally in a living organism. In the body the effective osmotic pressure of any solution is determined by the substances which are in this solution as well as by the permeability of cell membranes for these substances. Especially the latter is of crucial importance, because any substance which passes a cell membrane rapidly does not exert an osmotic effect on this cell membrane. It simply...
equilibrates rapidly on both sides of the membrane. An example of this is urea, which exerts an osmotic effect when measured in vitro.

In the human body however, urea will rapidly pass the cell membranes until the same concentration is achieved on both sides of the membrane. Thus, an in vitro measured hyperosmotic urea solution will behave as an isotonic solution in the body. The result will be that there is no osmotic fluid shift across the membranes.

A further clarification of terms seems important.

In vitro, osmolarity depends on the concentration of dissolved particles. Osmolarity can be measured by determination of freezing point depression. Freezing point depression is linearly related to the number of particles in solution. The measurement is expressed in mOsm/liter solution (osmolality). Another way of expression is as mOsm/kg water. In this case we speak of osmolality. Osmolarity is always higher than osmolality, since a liter of solution includes all particles, i. e. water content is < 1 liter.

Osmolarity or osmolality

In relation to a reference solution (hypooosmotic, isosmotic, hyperosmotic) is concerned only with the total concentration of dissolved particles, irrespective of the fact that these particles may or may not pass biological membranes rapidly.

Both values are real osmotic values, which should not be interchanged with the theoretically calculated value. The latter is based on theoretical complete dissociation of all particles in solution into their separate electrically loaded components.

The calculated value (e. g. 325 mOsm for blood) is always higher than the measured value. For physiological solutions only the measured value is the exact.

Budy fluids

The osmotic value of blood can be determined from 1) whole blood, 2) blood plasma, 3) blood serum. Osmolarities from „blood“ may vary a little according to this, when no specific reference is made, from about 275–300 mOsm/l (10–14). The osmolarity of whole blood as such is 320–322 mOsm/l. When intracellular water is taken as reference, the value may be as high as 310 mOsm/l.

Tonicity (hypotonic, isotonic, hypertonic) on the other side considers the concentration of those particles which can not pass the membrane rapidly. Such particles exert an effective osmotic pressure on one side of the cellmembrane.

Thus, with respect to the human body one speaks about an isotonic solution if this solution has the same effective osmotic pressure as that of a reference body fluid, for example whole blood, serum, plasma, or extracellular (interstitial) water.

Examples of particles which do not rapidly pass cellmembranes are proteins, aminoacids, glucose and minerals. These substances are generally transported by carrier mechanisms which are slow and may become saturated at higher concentration.

Changes in osmotic pressure

The osmolarity of body fluids will frequently undergo minor fluctuations, due to changes in fluid status. For example after ingestion of a salty solid meal it will increase, after ingestion of a large bolus of water it will decrease and after fluid loss due to sweating it will increase. These changes are small and are all temporary. The osmolarity of nutritional liquids in bottles, cans or tetra bricks may increase under influence of storage, time and temperature. This occurs because nutrients in solution may be hydrolyzed under influence of the added food acids. Thus a drink which is produced as isotonic solution with an osmotic value of 290 mOsm/l may increase to a value above 300 mOsm/l afer a few months of storage.

The claim „isotonic“

Temporal changes in blood and in drink osmolarity, as well as the differences between plasma, serum, whole blood and tissue fluid osmolarity, make it impossible to produce a solution which is exactly isotonic relative to bodyfluid. Therefore, it is generally accepted that solutions which deviate marginally from the osmotic values of body reference fluids, are claimed to be isotonic.

However, such general acceptance has never been laid down in any document to be used for food legislation or protection against false claims made by producers of oral rehydration drinks. For example, there are commercial products on the market with an osmotic value low as 240 mOsm or as high as 400 mOsm which are claimed to be isotonic.

Producers of oral rehydration solutions for sportsmen and -women should be aware of the terminology described here and should take care for quality control during processing and storage of products. At the same time a guideline should be established which determines what can be claimed as isotonic. Such a guideline should allow for some flexibility (deviation) because small changes in the osmolarity of bodyfluids due to metabolic processes, as well as small differences in osmolarity of products production and shelflife deviations make the establishment of an absolute value impossible.

Therefore it is proposed that isotonicity stands for the value of 300 mOsm/l ± 10%. isotonic range 270–330 mOsm/l.

In that case, the upper limit for a solution to bear the claim isotonic, will be 330 mOsm/l. This range of 60 mOsm will give some flexibility with respect to changes in product osmolarity due to partial hydrolysis of nutrients.

The rationale for the range, as presented here, has been discussed with the European food industries and has been forwarded by IDcN (Association of Dietetic Foods Industries of the E.E.C.) to the EC commision in Brussels as a guideline for future food legislation.

Literature

HPLC-Analyse von Biogenen Aminen und Aminosäuren in Nahrungsmitteln nach automatischer Vorsäulenderivatisierung mit 9-Fluorenylmethyl Chloroformiat (FMOC-Cl)

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Einleitung


Die bei der Derivatisierung von biogenen Aminen und Aminosäuren mit OPA und Thiolen gebildeten Isoindole weisen jedoch oftmals keine hinreichende Stabilität auf, so daß in letzter Zeit 9-Fluorenylmethyl-chloroformiat (FMOC-Cl) zur Vorsäulen-Derivatisierung von Aminen eingesetzt wurde [17-20].

Sowohl primäre als auch sekundäre Amine reagieren mit FMOC-Cl zur sehr stabilen und stark fluoreszierenden 9-Fluorenylmethyl-carbamaten (Abb. 1), und deshalb ist diese Reaktion sehr gut zur Vorsäulen-Derivatisierung von biogenen Aminen und Aminosäuren geeignet.

Experimenteller Teil

Geräte

D-6000 HPLC-Manager (Merck/Hitachi), L-6200A Intelligent Pump (Merck/Hitachi), T-6300 Column Thermostat (40°C Säulen Temperatur) (Merck), AS-4000 Intelligent Autosampler (Merck/Hitachi), F-1050 Fluorescence Spectrophotometer (Merck/Hitachi), (Ex. 265 nm, Em. 315 nm), HPLC-Säule: 250-4 Supersphere 60 RP-8 Säule (Merck).

Chemikalien

Die verwendeten Chemikalien wurden von kommerziellen Quellen, wie Fluka (Neu-Ulm), Merck (Darmstadt) und Sigma (Deisenhofen) bezogen. Alle Chemikalien wurden in der höchsten erhaltlichen Reinheit und ohne weitere Reinigung verwendet.

Herstellen der Standards