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Water

Water in food

Water for human consumption

Mineral water

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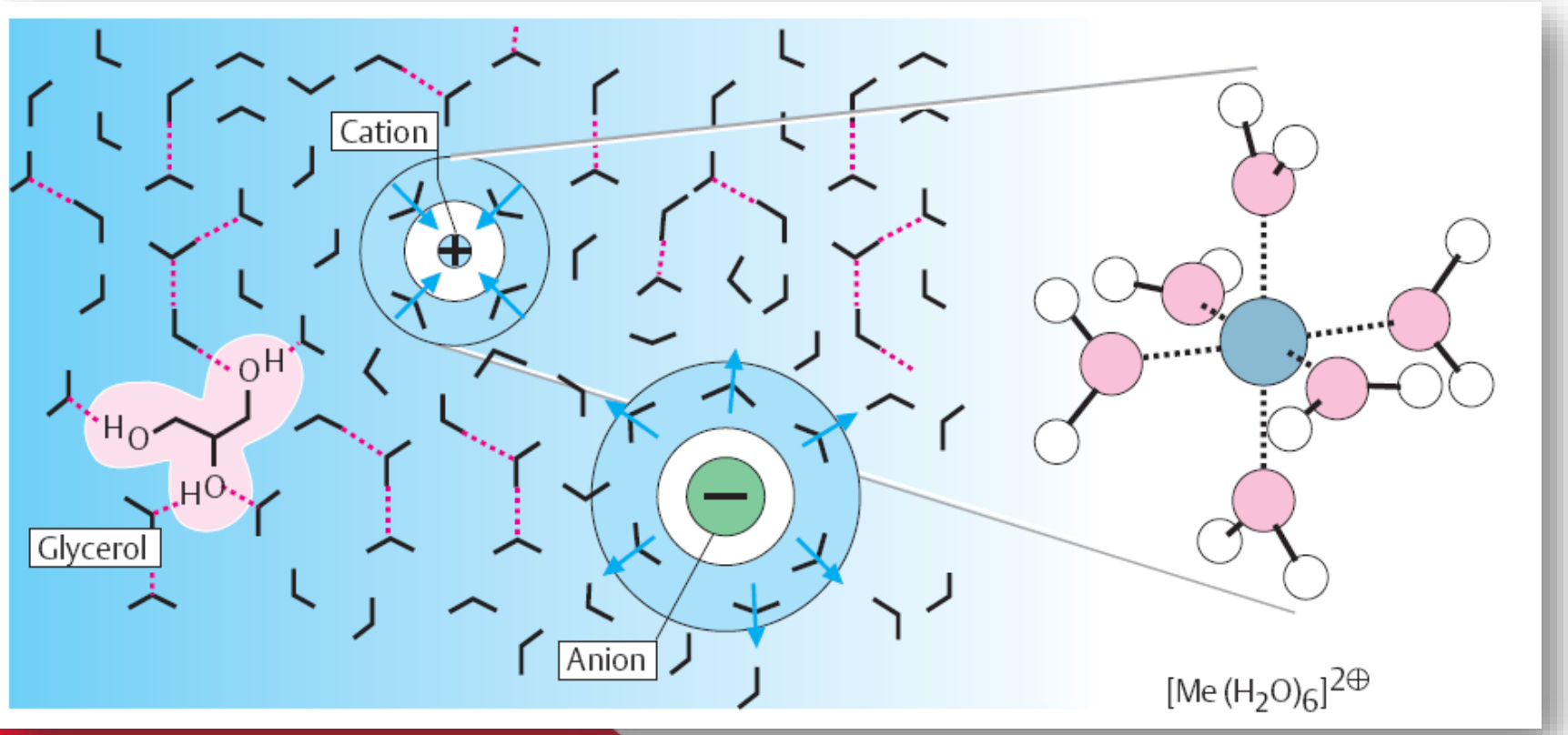
UNIT 1: Introduction, definition of free and bound water. Interaction with solutes, definition of water activity (a_w) and its role in food preservation.

UNIT 2: Water intended for human consumption: compositional characteristics: inorganic salts and organic species (hardness, chemical oxygen demand). Chemical and microbiological contamination, permitted treatments, regulatory notes.
Mineral waters: definition, origin, permitted treatments and reference legislation. Spring waters

Contents

Free Water: dispersing agent, emulsifier and solvent

Bound water: metal ion hydration water, crystallization water, monolayer and immobilized water



Koolman, Color Atlas of Biochemistry, 2nd edition 2005 Thieme

Classifications of Types of Water-Solute Interactions

Type	Example	Strength of interaction compared to water-water hydrogen bond [a]
Dipole-ion	Water-free ion Water-charged group on organic molecule	Greater[b]
Dipole-dipole	Water-protein NH Water-protein CO Water-sidechain OH	Approx. equal
Hydrophobic hydration	Water + R[c] $\rightarrow$ R(hydrated)	Much less ($\Delta G > 0$)
Hydrophobic interaction	R(hydrated) + R(hydrated) $\rightarrow$ R_2 (hydrated) + H_2O	Not comparable[d] (>hydrophobic interaction; $\Delta G < 0$)

[a]About 12-25 kJ/mol.

[b]But much weaker than strength of single covalent bond.

[c]R is alkyl group.

[d]Hydrophobic interactions are entropy driven, whereas dipole-ion and dipole-dipole interactions are enthalpy driven.

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MARCEL DEKKER

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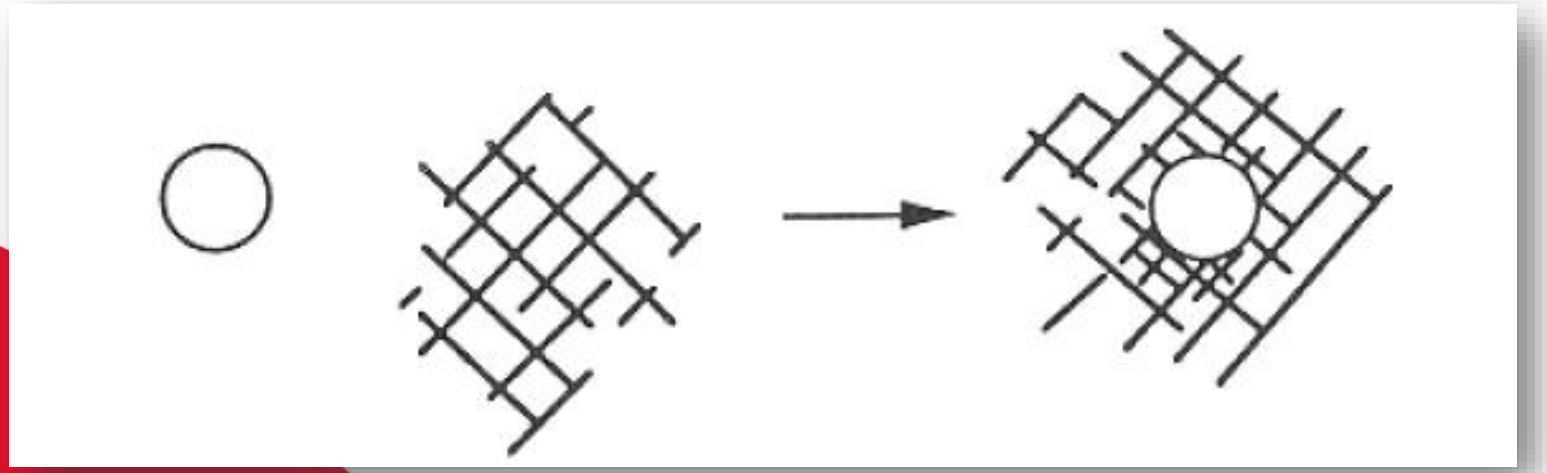
Lipids and Apolar Substances

the interaction of these compounds with water molecules is disadvantaged ($\Delta G>0$) above all due to the entropic contribution ($T\Delta S$ is negative) as the water molecules form highly ordered structures around the apolar solutes.

Hydrophobic hydration



Open circles are hydrophobic groups. Hatched areas are water.

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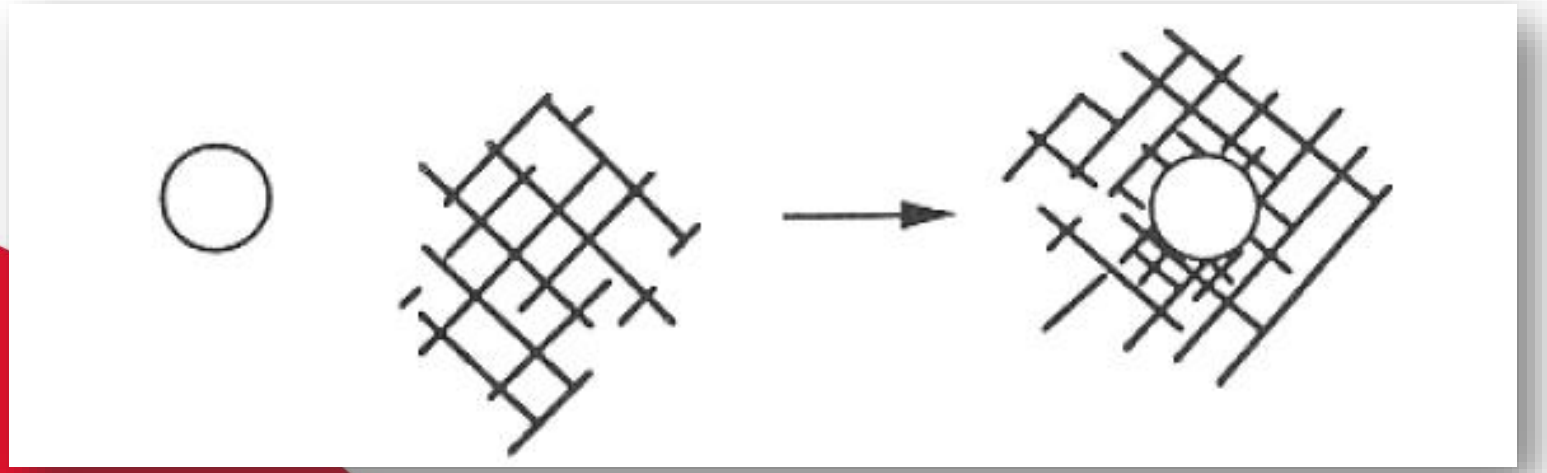

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formation of association complexes between apolar solutes in water in order to minimize the interaction surface.

Hydrophobic interaction

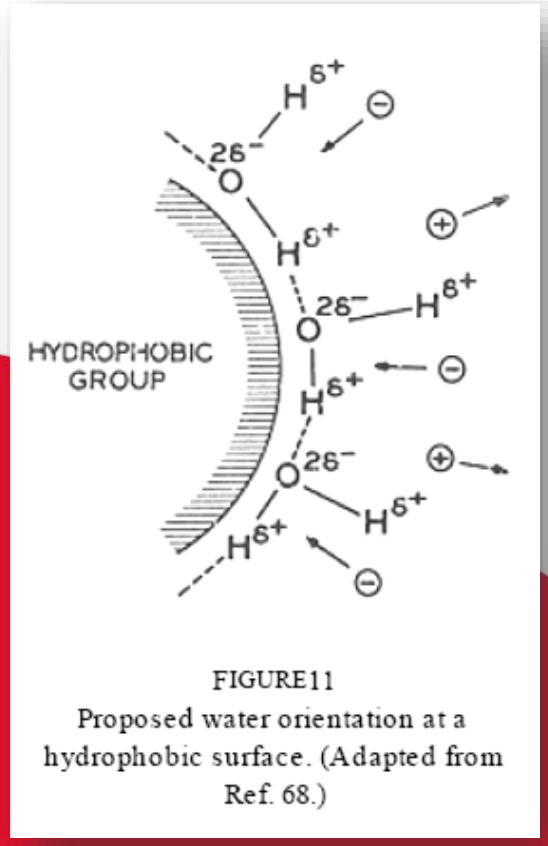

FIGURE11
Proposed water orientation at a hydrophobic surface. (Adapted from Ref. 68.)

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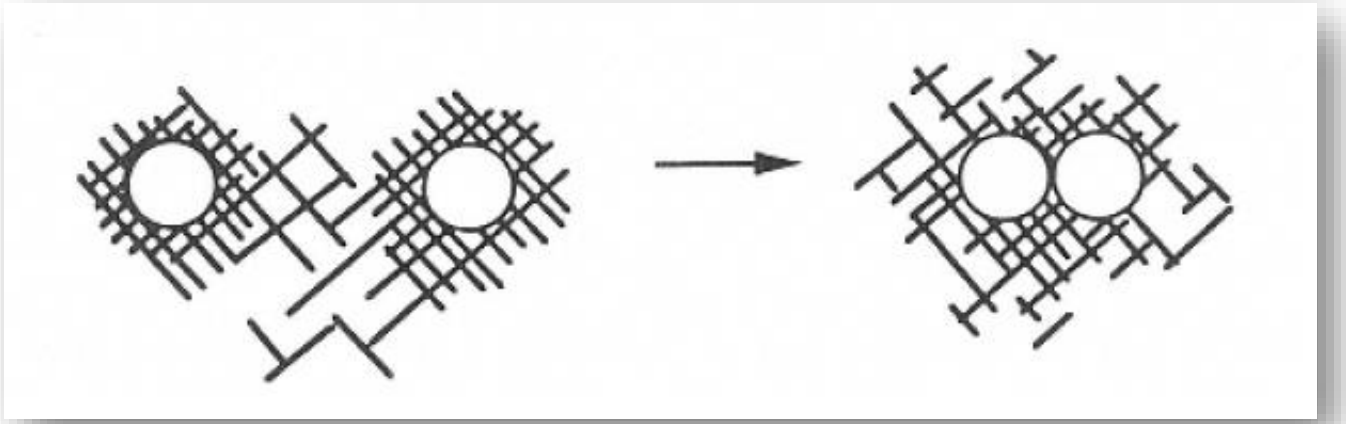

Open circles are hydrophobic groups. Hatched areas are water.

Complexes defined *clathrate hydrates*, are observed in foods for small molecules (amines, ammonium salts and sulfones) and for protein structures (globular protein) complex.

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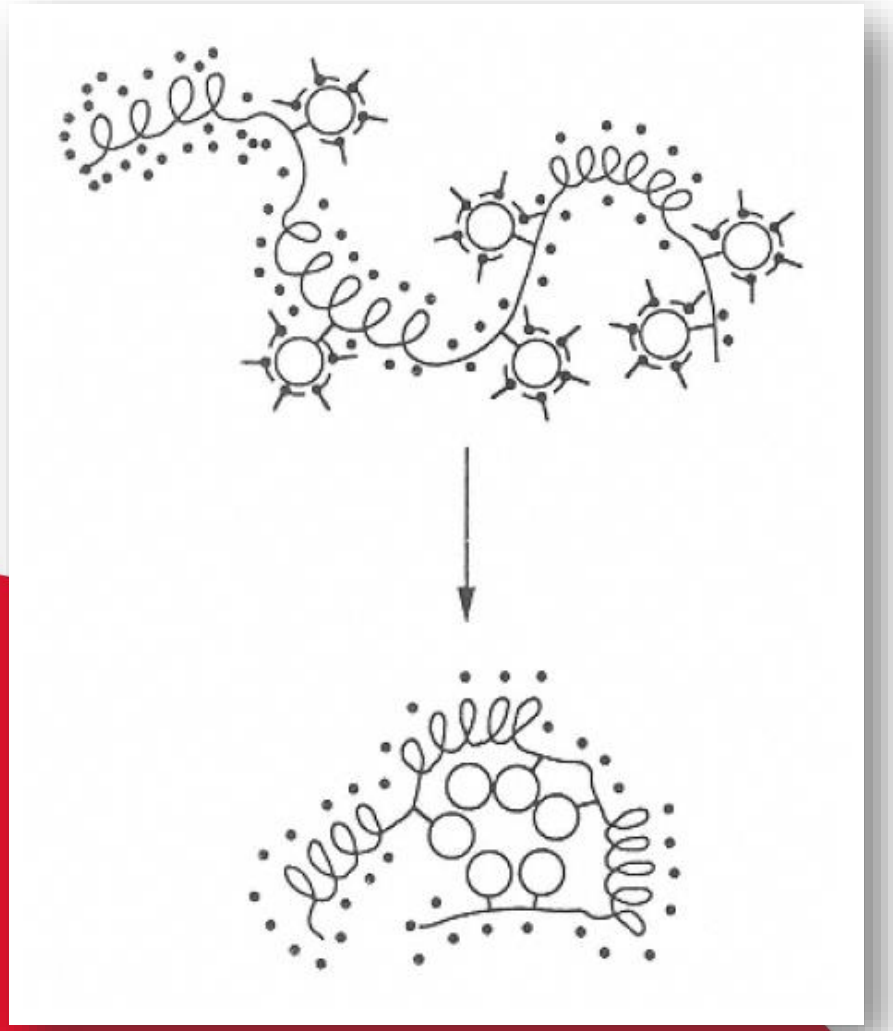

Schematic depiction of a globular protein undergoing hydrophobic interaction. Open circles are hydrophobic groups, "L-shaped" entities around circles are water molecules oriented in accordance with a hydrophobic surface, and dots represent water molecules associated with polar groups.

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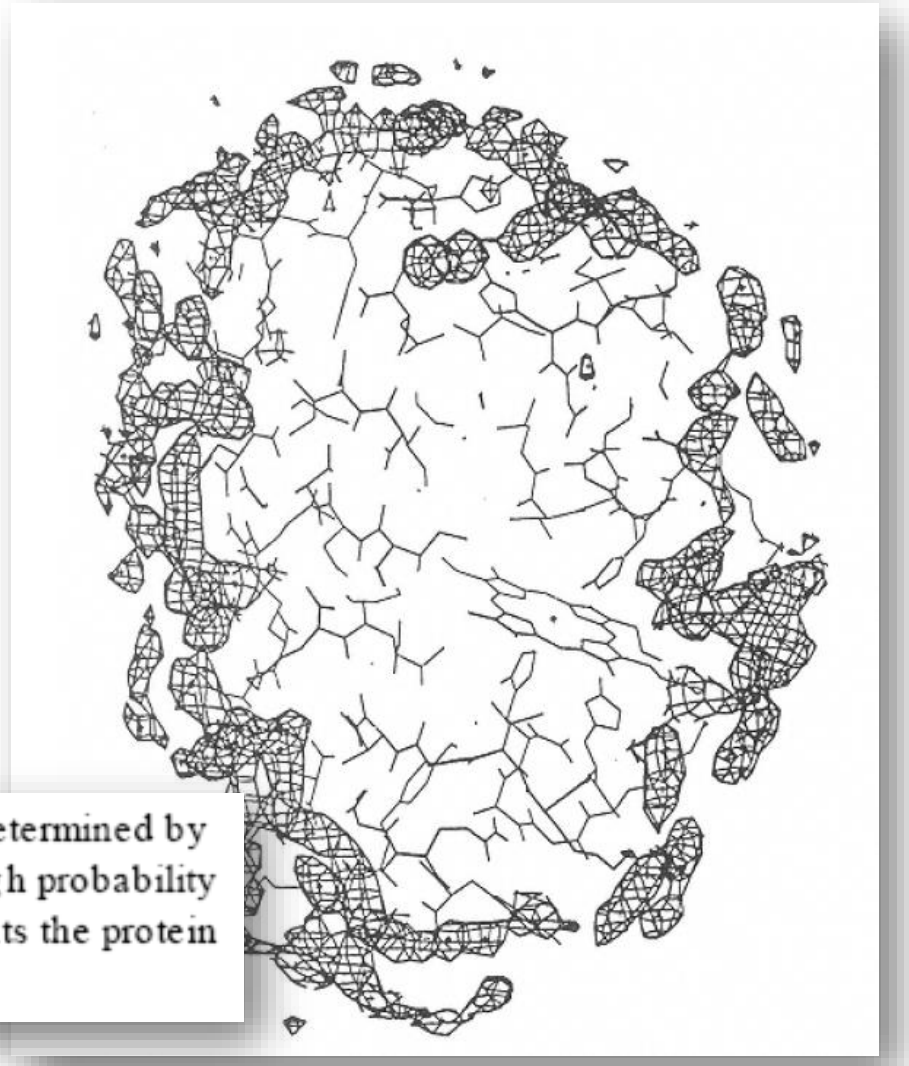

Cross-section of a hydrated myoglobin molecule as determined by molecular dynamics simulation. Mesh cages depict high probability sites of 1st-layer water molecules, stick figure represents the protein time-averaged structure. (From Ref. 72.)

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Lipids and Apolar Substances

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Properties	Constitutional water[b]	Hydration shell (≤3 Å from surface)			Bulk-phase water: Free[c]	Bulk-phase water: Entrapped[d]
General description for lysozyme	Constitutional water is assumed to be present in the dry protein at the onset of the hydration process. Water is first absorbed at sites of ionized, carboxylic and amino side chains, with about 40 mol water/mol lysozyme associating in this manner. Further absorption of water results in gradual hydration of less attractive sites, mainly amide carbonyl groups of the protein backbone. Attainment of true monolayer hydration of the protein is achieved at 0.38 g H_2O/g dry protein, by water associating with sites that are still less attractive. At this point, there is, on average, 1 HOH/20 $Å^2$ of protein surface				Fully hydrated	Fully hydrated
Approximate water content: g H_2O/g dry protein (h) mol H_2O/mol dry protein wt% based on lysozyme	<0.01 h <8 1%	0.01–0.07 h 8–56 1–6.5%	0.07–0.25 h 56–200 6.5–20%	0.25–0.58 h 200–304 20–27.5%	> 0.38 h > 304 > 27.5%	> 0.38 h >304 >27.5%
Location on isotherm[e] Relative vapor pressure (p/p_0) Zone	<0.02 p/p_0 Zone I, extreme left	0.02–0.2 p/p_0 Zone I	0.2–0.75 p/p_0 Zone IIA	0.75–0.85 p/p_0 Zone IIB	> 0.85 p/p_0 Zone III	> 0.85 p/p_0 Zone III
Water properties					Normal	Normal
Structure	Critical part of native protein structure	Water interacts principally with charged groups (~2 HOH/group) At 0.07 h: transition in surface water from disordered to ordered and/or from dispersed to clustered	Water interacts principally with polar protein surface groups (~1 HOH/ polar site) Water clusters centered on charged and polar sites Clusters fluctuate in size and/or arrangement	At 0.25 h: start of condensation of water onto weakly interacting unfilled patches of protein surface At 0.38 h: monolayer of water covers the surface of the protein and water		

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Lipids and Apolar Substances

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Properties	Constitutional water[b]	Hydration shell (≤3 Å from surface)			Bulk-phase water: Free[c]	Bulk-phase water: Entrapped[d]
		state; associated with completion of charged group hydration	At 0.15 h: long-range connectivity of the surface water is established	phase begins to form, and glass-rubber transition occurs		
Thermodynamic transfer properties[f]						
$\Delta \bar{G}$ (kJ/mol)	> |-6|	-6	-0.8	Close to bulk water	NA	NA
$\Delta \bar{H}$ (kJ/mol)	> |-17|	-70	-2.1	Close to bulk water	NA	NA
Approximate mobility (residence time)	10^{-2} to 10^{-8} sec	$<10^{-8}$ sec	$< 10^{-9}$ sec	$< 10^{-9}$ to 10^{-11} sec	10^{-11} to 10^{-12} sec	10^{-11} to 10^{-12} sec
Freezability	Unfreezable	Unfreezable	Unfreezable	Unfreezable	Normal	Normal
Solvent capability	None	None	None to slight	Slight to moderate	Normal	Normal
Protein properties						
Structure	Folded state stable	Water begins to plasticize amorphous regions	Further plasticization of amorphous regions			
Mobility	Enzymatic activity negligible	Enzymatic activity negligible	Internal protein motion (H exchange) increases from 1/1000 at 0.04 h to full solution rate at 0.15 h At 0.1–0.15 h: chymotrypsin and some other enzymes develop activity	At 0.38 h: lysozyme specific activity is 0.1 that in dilute solution	Maximum	Maximum

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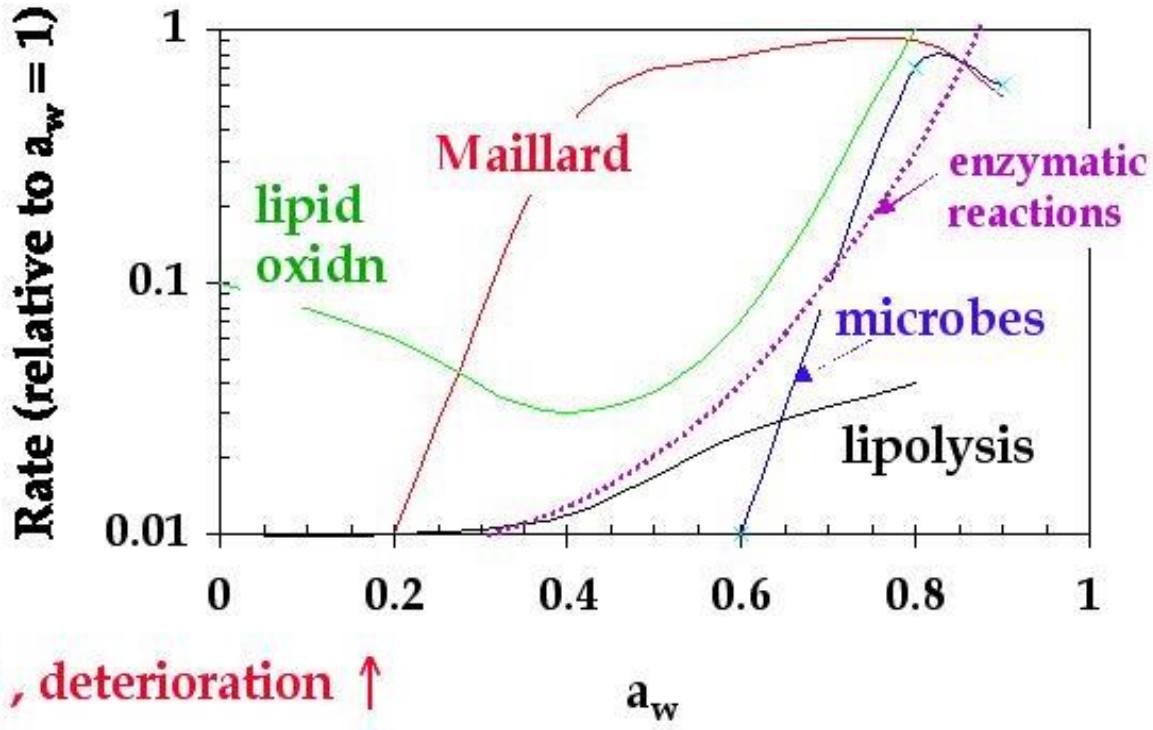
Water activity a_w

- Food deterioration processes strong function of a_w



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Indicated with the acronym a_w (water activity) it represents the fraction of unbound water which acts as a medium for bacterial reproduction, as a solvent for desirable or not desirable chemical reactions

Water activity a_w

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The water activity (a_w) of a food is the ratio between the vapor pressure in the food (p_a), when in a completely undisturbed balance with the surrounding air media, and the vapor pressure of distilled water under identical conditions (p_0).

$a_w = p_a/p_0$

A water activity of 0.80 means the vapor pressure is 80 percent of that of pure water. The water activity increases with temperature. The moisture condition of a product can be measured as the equilibrium relative humidity (ERH) expressed in percentage or as the water activity expressed as a decimal.

$$a_w = p_a/p_0 = \text{ERH } \%/100 = n_1/(n_1+n_2)$$

where n_1 solvent moles
n_2 solute moles

Water activity a_w

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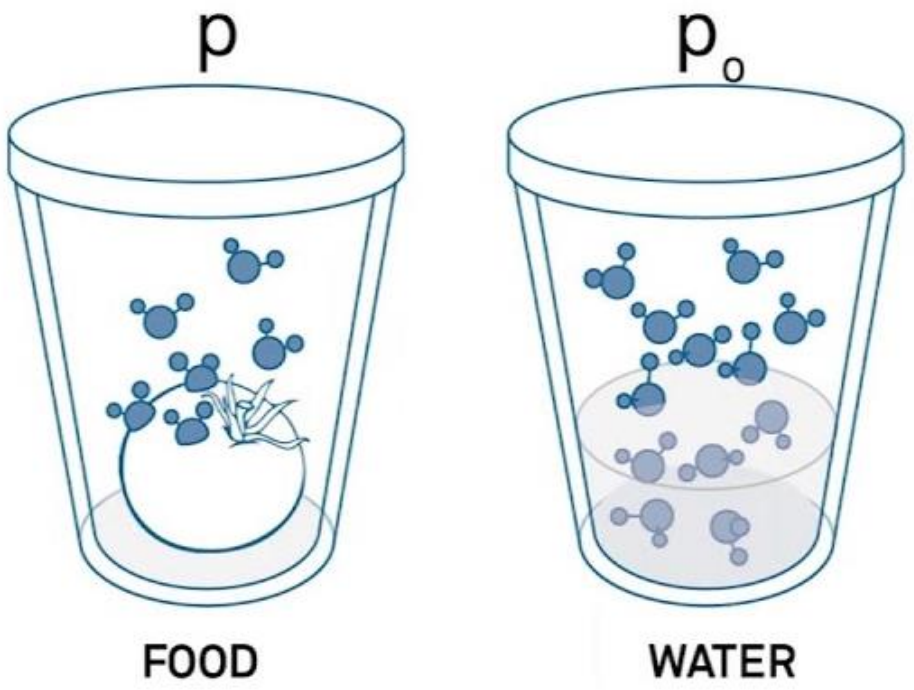
$a_w = p/p_0$

Requirements

- Equilibrium
- Constant Temperature and Pressure



Note: water activity and moisture content are correlated but not the same parameter. Moisture is determined with a gravimetric test by evaporation of the free water until stable weight (gravimetric test).

Water activity a_w

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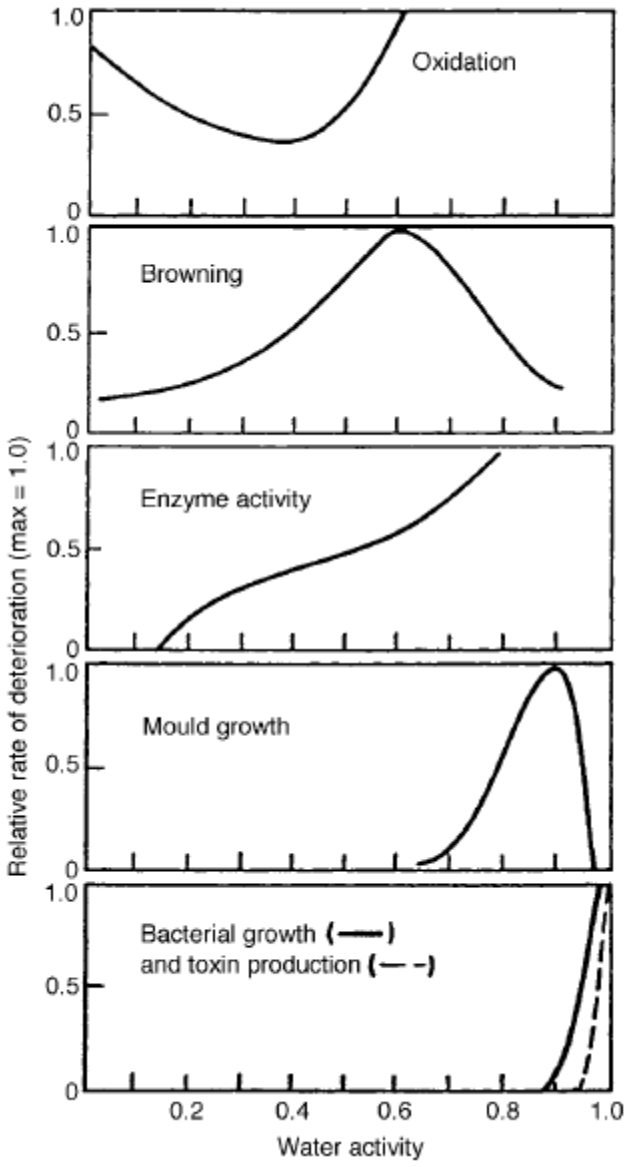

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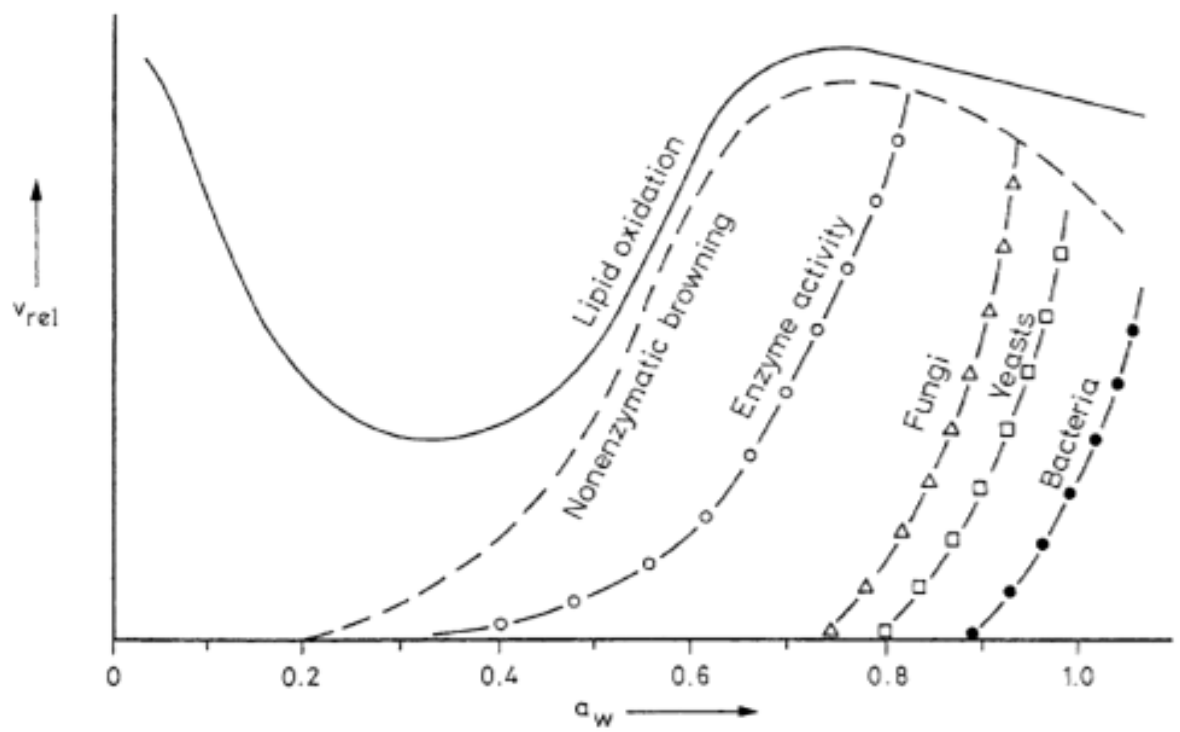

Fig. 0.4. Food shelf life (storage stability) as a function of water activity (according to *Labuza*, 1971)

Water activity a_w

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a_w is a temperature/dependent parameter according to the *Clausius-Clapeyron* equation:

$$\frac{d \ln a_w}{d\left(\frac{1}{T}\right)} = \frac{-\Delta H}{R}$$

Where:
T is the absolute temperature
R constant of gases
ΔH is the enthalpy of water diffusion at constant volume

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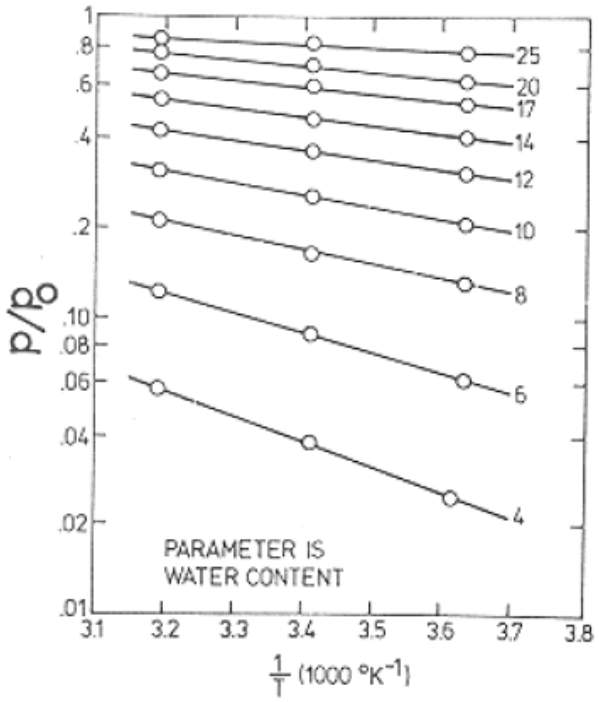
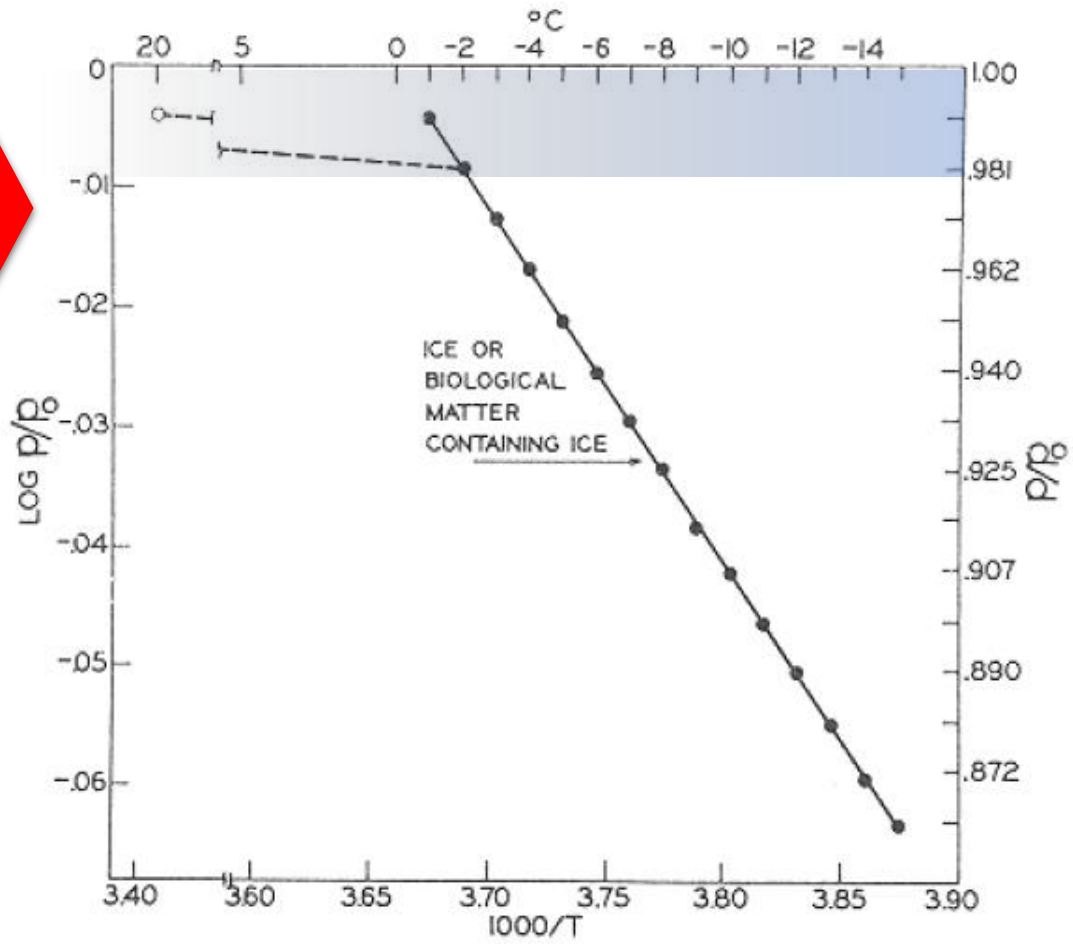
The graph shows the trend of the p_a/p_0 values as a function of the absolute temperature of the system for potato starch samples at different values of % water on dry weight
(g H_2O/g starch).

The a_w value follows a linear trend (range 2-40°C) and decreases with the inverse of the absolute temperature of the system with the same % of water in the sample.



Water activity a_w

Trend of the p/p_0 value as a function of the system temperature below the freezing point



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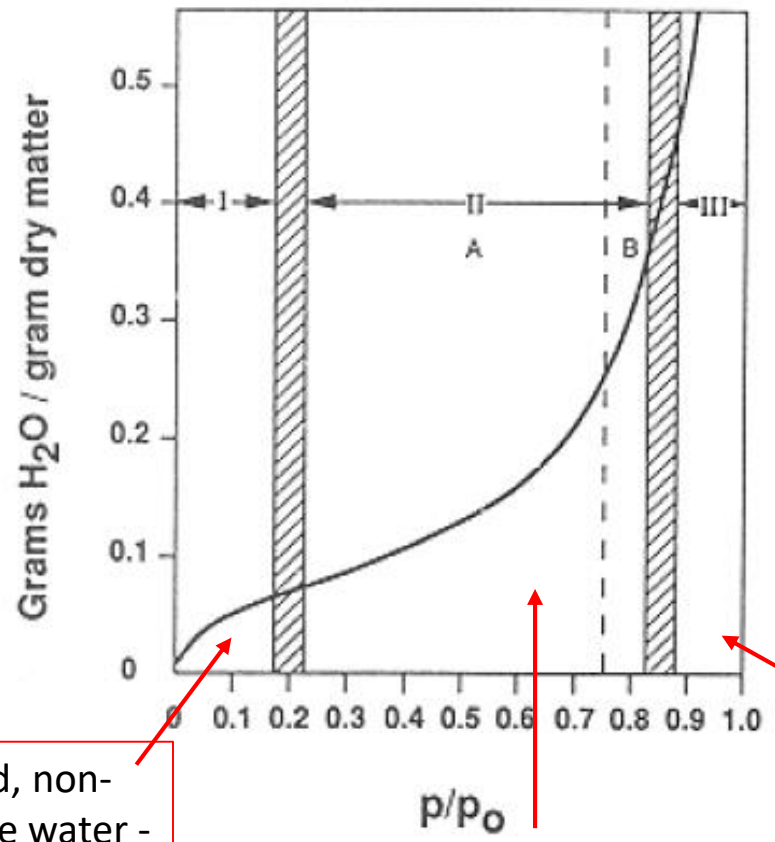
Water activity a_w

Relationship between the % of water contained in a food (g H_2O/g of dry weight) and the a_w value (at constant T).

Moisture Sorption Isotherm - MSI

It describes phenomena such as:
- dehydration and concentration;
- water transfer between ingredients;
- determination of permeability by a packaging;
- study of stability.



Bound, non-mobile water - no solvent properties

Monolayer- BET H-bonds and access to interaction sites with polar molecules. Non-freezable water at -40°C

Once the monolayer is completed, there is a fraction of unbound water - acting as solvent which modifies the rheological properties of the food. Freezable water

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Water activity a_w

Relationship between the % of water contained in a food (g H_2O/g of dry weight) and the a_w value (at constant T).

Moisture Sorption Isotherm

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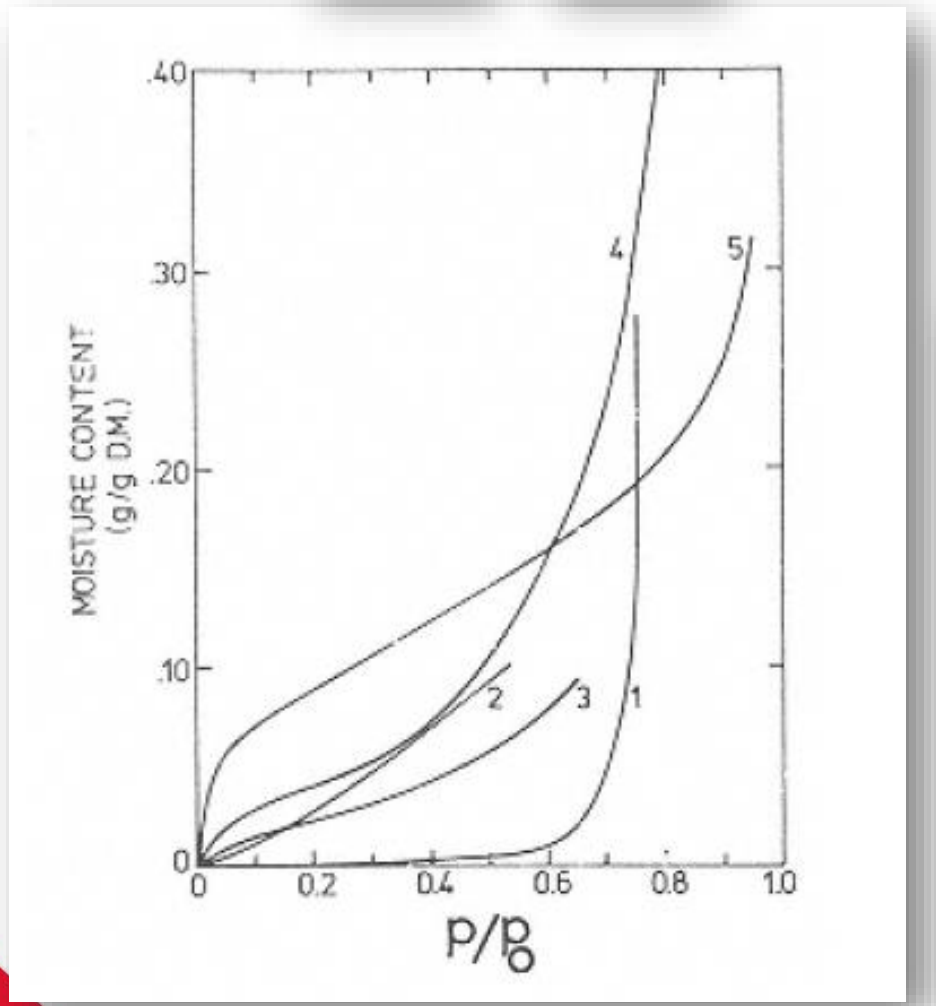

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Resorption isotherms for various foods and biological substances. Temperature 20°C, except for number 1, which is 40°C: (1) confection (main component powdered sucrose), (2) spray-dried chicory extract, (3) roasted Columbian coffee, (4) pig pancreas extract powder, (5) native rice starch. (From Ref. 127.)

Water activity a_w

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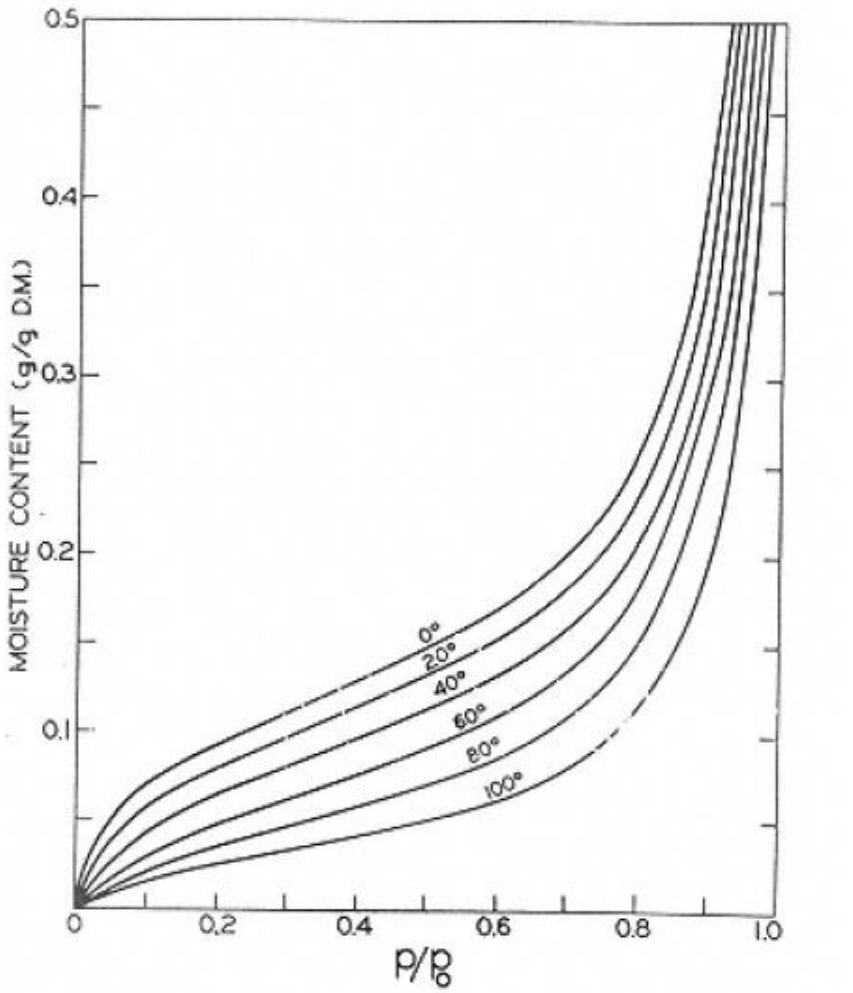
The solvation isotherms have different profiles also as a function of the system temperature.



Moisture desorption isotherms for potatoes at various temperatures. (Redrawn from Ref. 35.)

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Water for human consumption
Drinking water or potable water

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Water intended for human consumption must be wholesome and clean

- ✓ SAFE: no contaminants and harmful microorganisms
- ✓ USEABLE: available and distributed in a suitable way
- ✓ ACCEPTABLE: clear, odourless, colourless, tasteless.

QUALITY REQUIREMENTS

- ✓ Hydrogeological criteria;
- ✓ Organoleptic criteria;
- ✓ Physical Criteria;
- ✓ Chemical Criteria

Water for human consumption
Drinking water standards Italy

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Tabella 1 - Confronto fra rispettivi valori limite per i componenti principali (parametri di composizione) tra le due tipologie di acqua.

Parametri di composizione e altri	Unità di misura	Valori parametrici acque potabili (D. Lgs. 31/2001)	Valori limite acque minerali (Art. 5 D.M. 542/1992)
Conducibilità elettrica	µS/cm	2.500	-(1)
pH	Unità pH	≥6,5 e ≤9,5	-
Ossidabilità	mg/L O_2	5,0	-
Durezza	°F	15-50 (2)	-
Residuo fisso	mg/L	1.500 (3)	-
Cloruri	mg/L Cl^-	250	-
Solfati	mg/L SO_4^{2-}	250	-
Bicarbonato	mg/L HCO_3^-	-	-
Sodio	mg/L Na^+	200	-
Potassio	mg/L K^+	-	-
Calcio	mg/L Ca^{++}	-	-
Magnesio	mg/L Mg^{++}	-	-

(1) Quando non è riportato alcun dato, significa che nessun valore è previsto.
(2) Il limite inferiore vale per le acque sottoposte a trattamento di addolcimento o di dissalazione.
(3) È un valore massimo consigliato, indicato nella tabella C – "Parametri indicatori" dell'Allegato I del D. Lgs 31/2001.

Water for human consumption
Hardness

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Water hardness or **hardness in water** is a measure of the **amount of calcium and magnesium ions in the water.** The more calcium and magnesium the water contains, the harder the water.

Total hardness: relates to all Ca^{2+} e Mg^{2+} salts (HCO_{3-}, $SO_4 2^-$, Cl^-, NO_3^-) it is generally referred to as French degrees (°F) corresponding to 10mg/L of $CaCO_3$ (hard if > 18-20°F)

Temporary hardness: relates to the presence of bicarbonates of Ca^{2+} e Mg^{2+} by heating the water sample at the boiling point they precipitate as carbonates ($CaCO_3$ and $MgCO_3$) while the CO_2 is lost in form of gas

$Ca(HCO_3)_2 \rightleftharpoons CaCO_3 + CO_2 + H_2O$

$Mg(HCO_3)_2 \rightleftharpoons MgCO_3 + CO_2 + H_2O$

Permanent hardness: relates to the presence of soluble salts of Ca^{2+} e Mg^{2+} (SO_4^{2-}, Cl^-, NO_3^- etc) even after water boiling.

Water for human consumption
Hardness

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GRADI °f (francesi)	VALUTAZIONE
0 - 7	Acqua molto dolce
8 - 14	Acqua dolce
15 - 24	Acqua media durezza
25 - 32	Acqua abbastanza dura
33 - 42	Acqua dura
> 42	Acqua molto dura

Water for human consumption
Organic substances contamination

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Chemical Oxygen Demand (COD or oxidizability) or in major components, organic nitrogen (Kjeldhal method) and organic carbon (TOC **Total Organic Carbon**) are indicators of the presence of organic matter (which is not desirable).

The fixed limit corresponds to 5 mg/L of O_2 expressed as

Oxidability number or **Kubel number***: indicates the milligrams of oxygen released by an acid solution of potassium permanganate which are necessary to oxidize the organic substances contained in 1L of water.

For the determination, a solution of $KMnO_4$ N/100 is used, 1mL of which corresponds to 0.08 mg of oxygen. (1 0.01 = x/ ½ O_2 ; 0.08 mg).

Reaction:

$$2\ KMnO_4 + 5\ H_2C_2O_4 + 3\ H_2SO_4 = K_2SO_4 + 2MnSO_4 + 10\ CO_2 + 8H_2O$$

*Kubel number is used in Italy

Water for human consumption
Microbial contamination

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Tabella 3 - Confronto fra i rispettivi valori limite dei parametri microbiologici delle due tipologie di acqua.

Parametro	Valori limite acque potabili (D. Lgs. 31/2001)	Valori limite acque minerali (Art. 9 D.M. 542/1992)
Carica microbica a 20°-22°C per 72 ore	100 UFC/mL (2)	100 UFC/mL (1)
Carica microbica a 37°C per 24 ore	20 UFC/mL (2)	20 UFC/mL (1)
Escherichia coli	0 UFC in 100 mL - 0 UFC in 250 mL (2)	-
Enterococchi	0 UFC in 100 mL - 0 UFC in 250 mL (2)	-
Coliformi totali	0 UFC in 100 mL (3)	0 UFC in 250 mL in 2 repliche
Coliformi fecali	-	0 UFC in 250 mL in 2 repliche
Streptococchi fecali	-	0 UFC in 250 mL in 2 repliche
Clostridi solfito-riduttori (spore)	-	0 UFC in 50 mL
Clostridium perfringens (spore comprese)	0 UFC in 100 mL (4)	-
Staphylococcus aureus	-	0 UFC in 250 mL
Pseudomonas aeruginosa	0 UFC in 250 mL (2)	0 UFC in 250 mL

(1) Limite indicativo entro 12 ore dall'imbottigliamento ai sensi della Circolare Ministero della Sanità n. 17 del 13/09/1991.
(2) Valori da applicare per acque potabili confezionate.
(3) Per le acque confezionate in bottiglie o contenitori, il valore è 0 UFC in 250 mL.
(4) Tale parametro non deve essere misurato a meno che le acque provengano o siano influenzate da acque superficiali. In caso di non conformità con il valore parametrico, l'Azienda sanitaria locale competente al controllo dell'approvvigionamento d'acqua deve accertarsi che non sussistano potenziali pericoli per la salute umana derivanti dalla presenza di microrganismi patogeni quali ad esempio il *Cryptosporidium*. I risultati di tutti questi controlli debbono essere inseriti nelle relazioni che debbono essere predisposte ai sensi dell'articolo 18, comma 1, del D. Lgs 31/2001.

Water for human consumption
European legislation framework and Drinking Water Directive

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DIRECTIVE (EU) 2020/2184 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2020 on the quality of water intended for human consumption

The Directive applies to

all water, either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes in both public and private premises, regardless of its origin and whether it is supplied from a distribution network, supplied from a tanker or put into bottles or containers, including spring waters; all water used in any food business for manufacturing, processing, preserving or marketing of products or substances intended for human consumption.

https://environment.ec.europa.eu/topics/water/drinking-water_en

Water for human consumption
European legislation framework and Drinking Water Directive

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Key features of the revised Directive are:

- ✓ reinforced water quality standards, in line or, in some cases, even more stringent than the World Health Organisation (WHO) recommendations
- ✓ tackling emerging pollutants, such as endocrine disruptors and PFAs, as well as microplastics
- ✓ a preventive approach favouring actions to reduce pollution at source by introducing the risk-based approach
- ✓ measures to ensure better access to water, particularly for vulnerable and marginalized groups
- ✓ measures to promote tap water, including in public spaces and restaurants, to reduce (plastic) bottle consumption
- ✓ harmonization of the quality standards for materials in contact with water
- ✓ measures to reduce water leakages and to increase transparency of the sector

https://environment.ec.europa.eu/topics/water/drinking-water_en

Water for human consumption

Water potabilization

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Drinking water can have various origins:

- ✓ groundwater and/or surface water
- ✓ brackish water (suitably treated)

Surface freshwater intended for the production of drinking water is classified according to its quality level pursuant to art. 80 of Italian Legislative Decree 03/04/2006, n. 152.

Three categories are defined in descending order of quality: A1, A2 and A3. Passing from class A1 to the following ones, increasingly complex and accurate purification processes are required.

https://environment.ec.europa.eu/topics/water/drinking-water_en

Water for human consumption

Water purification

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https://environment.ec.europa.eu/topics/water/drinking-water_en

Water for human consumption

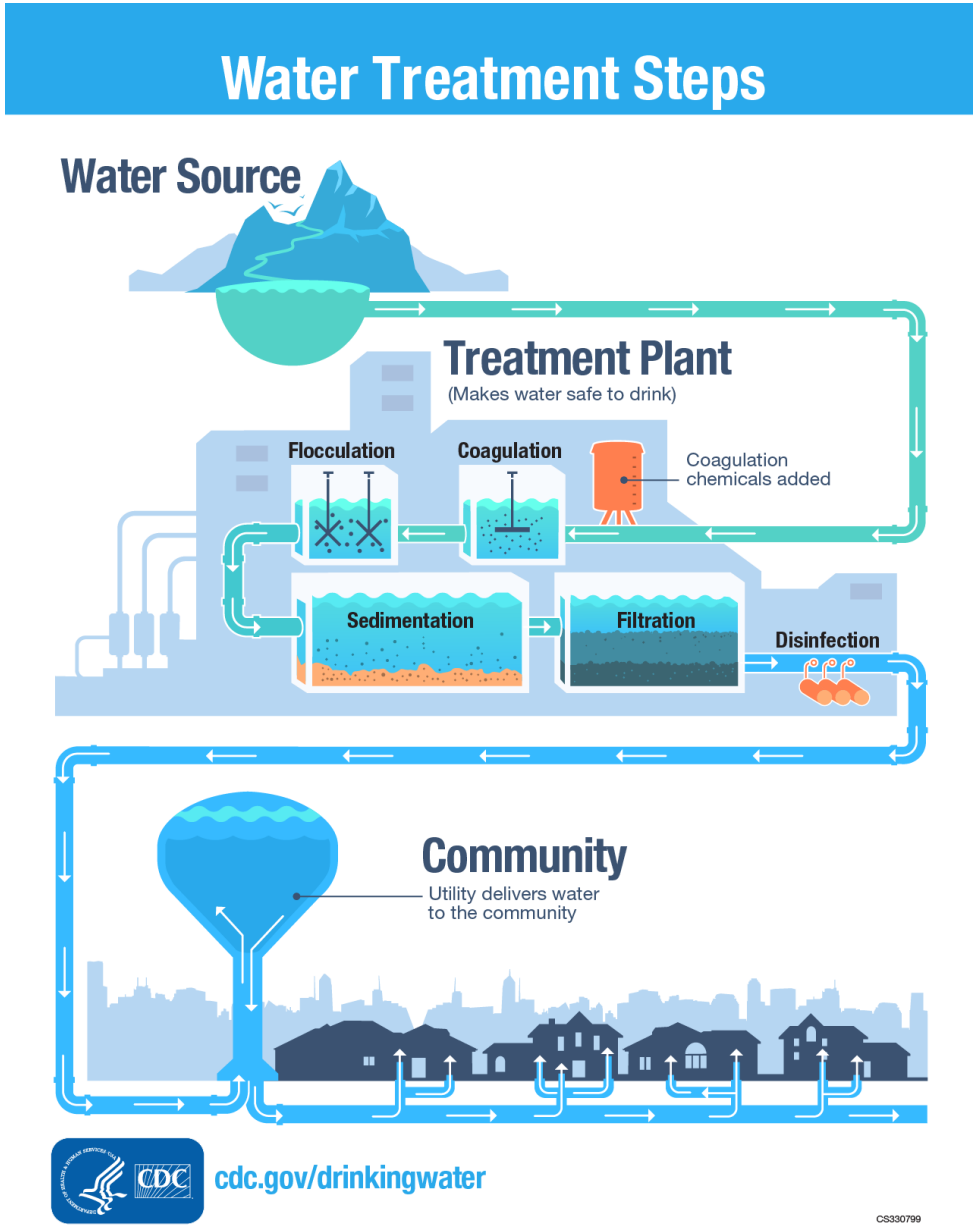
Water purification

PERMITTED TREATMENTS

- ✓ physical treatments
- ✓ chemical treatments
- ✓ specific treatments

Disinfection aims to eliminate or reduce any microbial populations to acceptable levels.

Treatment with chlorine dioxide does not induce the formation of organohalogen compounds, but gives rise to the production of chlorite for which a limit of 0.7 mg/L has recently been redefined.



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Mineral water & Co.

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All natural mineral and spring waters are strictly regulated under EU law.
Specific legislation applies to the three different categories of bottled water.

Natural Mineral Water

- Directive 2009/54/EC on the exploitation and marketing of natural mineral waters

Spring Water

- Regulated partly by Directive 2009/54/EC on the exploitation and marketing of natural mineral waters
- Directive 98/83/EC on the quality of water intended for human consumption.

Bottled Drinking Water

In Italia non ammesse

- Directive 98/83/EC relating to the quality of water intended for human consumption.

Natural Mineral Waters and Spring Waters

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Natural mineral waters may be distinguished from ordinary drinking water by their purity at source and their constant level of minerals.
Spring waters are intended for human consumption in their natural state and are bottled at source.

DEFINITION

'Natural mineral water' means microbiologically wholesome water, within the meaning of Article 5, originating in an underground water table or deposit and emerging from a spring tapped at one or more natural or bore exits.

Natural mineral water can be clearly distinguished from ordinary drinking water:

(a) by its nature, which is characterised by its mineral content, trace elements or other constituents and, where appropriate, by certain effects;

(b) by its original purity,

both characteristics having been preserved intact because of the underground origin of such water, which has been protected from all risk of pollution.

Natural Mineral Waters and Spring Waters

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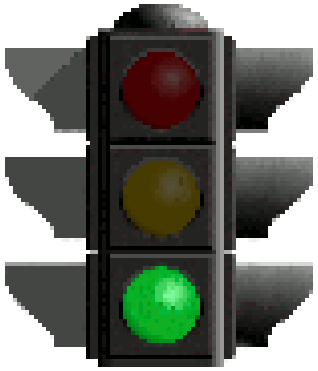
PERMITTED TREATMENTS

Mineral waters are not subjected to disinfection. The permitted and prohibited treatments are expressly indicated in the articles 7 and 8 of the Italian Legislative Decree 105/1992:



a) uptake, canalization, mechanical elevation, supply in tanks or reservoirs;
b) separation of the unstable elements, such as iron and sulfur compounds, by filtration or decantation, possibly preceded by oxygenation…;
c) separation of iron, manganese and sulfur compounds as well as arsenic from certain natural mineral waters by treatment with ozone-enriched air…;
d) separation of undesirable components other than those mentioned in letters b) and c) …;
e) total or partial elimination of free carbon dioxide by exclusively physical processes, as well as incorporation or re-incorporation of carbon dioxide….

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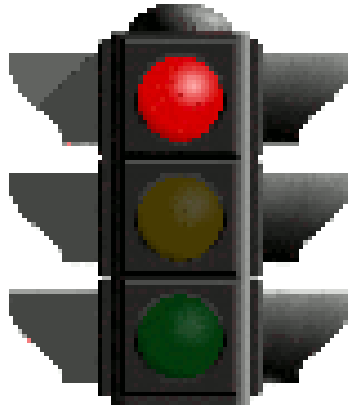
TREATMENTS NOT ALLOWED

Article 8…
It is forbidden to subject natural mineral water to operations other than those provided for in art. 7.
In particular, purification treatments, the addition of bactericidal or bacteriostatic substances and any other treatment likely to modify the microbial balance of natural mineral water are prohibited.



Finally, it should be noted that mineral waters cannot be transported (for example in tankers or ships), but only carried through the supply pipes from the collection point to the plant and then packaged at the origin.

Mineral waters can be bottled in containers with a maximum capacity of two liters (art. 4, paragraph 10, Legislative Decree 105/1992). On the other hand, there are no capacity limits for packaging drinking water.

Natural Mineral Waters "claims"

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Indicazioni aggiuntive

Possono essere riportate (non è obbligatorio) anche le seguenti indicazioni:

a) "oligominerale" o "leggermente mineralizzata", se il tenore dei sali minerali, calcolato come residuo fisso, non è superiore a 500 mg/l;

b) "minimamente mineralizzata", se il tenore di questi, calcolato come residuo fisso, non è superiore a 50 mg/l;

c) "ricca di sali minerali", se il tenore di questi, calcolato come residuo fisso, è superiore a 1500 mg/l;

d) "contenente bicarbonato" se il tenore di bicarbonato è superiore a 600 mg/l;

e) "solfata" se il tenore dei solfati è superiore a 200 mg/l;

f) "clorulata", se il tenore di cloruro è superiore a 200 mg/l;

g) "calcica", se il tenore di calcio è superiore a 150 mg/l;

h) "magnesiaca", se il tenore di magnesio è superiore a 50 mg/l;

i) "fluorata" o "contenente fluoro", se il tenore di fluoro è superiore a 1 mg/l;

l) "ferruginosa" o "contenente ferro", se il tenore di ferro bivalente è superiore a 1 mg/l;

m) "acidula", se il tenore di anidride carbonica libera è superiore a 250 mg/l;

n) "sodica", se il tenore di sodio è superiore a 200 mg/l;

o) "indicata per le diete povere di sodio", se il tenore di sodio è inferiore a 20 mg/l;

p) "microbiologicamente pura".

Natural Mineral Waters "claims"

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Indicazioni aggiuntive

Inoltre sulle etichette o sui recipienti delle acque minerali naturali possono essere riportate una o più delle seguenti indicazioni, se menzionate nel decreto di riconoscimento dell'acqua minerale:

a) può avere "effetti diuretici";
b) "può avere effetti lassativi";
c) "indicata per l'alimentazione dei neonati";
d) "indicata per la preparazione degli alimenti dei neonati";
e) "stimola la digestione" o menzioni analoghe;
f) "può favorire le funzioni epatobiliari" o menzioni analoghe;
g) altre menzioni concernenti le proprietà favorevoli alla salute, sempre che dette menzio attribuiscano all'acqua minerale naturale proprietà per la prevenzione, la cura e la guarigi una malattia umana;
h) le eventuali indicazioni per l'uso;
i) le eventuali controindicazioni.

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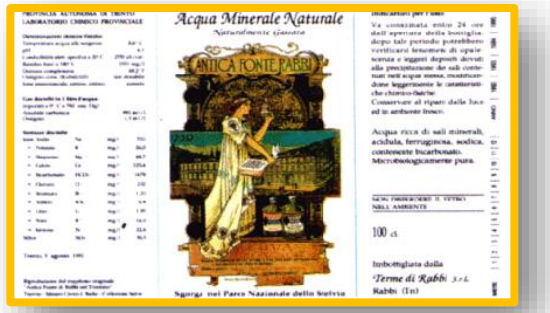
RICERCA ACQUE ITALIANE

RISULTATO

DENOMINAZIONE	COMUNE	PR.	REGIONE
acetosella	castellammare di stabia	na	campania
acqua della madonna	castellammare di stabia	na	campania
acqua di nepi	nepi	vt	lazio
acqua forte		gr	toscana
acqua sacra	roma	rm	lazio
agnano	s.giuliano terme	pi	toscana
antica fonte rabbi	rabbi	tn	trentino alto adige
appia	roma	rm	lazio
ausonia	bognanco	vb	piemonte
capannelle	roma	rm	lazio

DATI GENERALI

LOCALITÀ: FONTI DI RABBI, 162 - 38020
COMUNE: RABBI
Provincia: TN
Regione: TRENTINO ALTO ADIGE
QUOTA: 1250m s.l.m
SORGENTE: ANTICA FONTE
AUTORIZZAZIONE:
PRODOTTA DA: TERME di RABBI S.r.l.
SITO WEB: www.termedirabbi.it
Acqua Minerale Naturale, Ricca in Sali
Bicarbonata Clorurata Sodica Effervescente naturale



SOSTANZE DISCIOLTE IN UN LITRO DI ACQUA ESPRESSE IN

- Calcio (Ca++): 123,4
- Magnesio (Mg++): 44,9
- Sodio (Na+): 510
- Potassio (K+): 26
- Bicarbonato (HCO_3-): 1670
- Solfato (SO_4--): 6,8
- Cloruro (Cl-): 232
- Nitrato (NO_3-): n.d.
- Fluoruro (F-): n.d.
- Litio (Li+): 1,95
- Stronzio (Sr++): n.d.
- Nitriti (NO_2-): n.d.
- Ammonio (NH_4+): n.d.
- Ioduro (I-): n.d.
- Bromuro (Br-): n.d.
- Silice (SiO_2): 30,5
- Idrogeno Solforato : n.d.
- Grado solfidrometrico (H_2S): n.d.

NOTE:

In passato l'acqua veniva imbottigliata in piccoli contenitori, sigillati con tappo di sughero e ceralacca, oggi l'utilizzo è escusivo presso il centro Termale, in particolare per la cura di affezioni su base vascolare.

Spring Waters

From a legislative point of view, spring waters occupy a hybrid position between waters intended for human consumption and natural minerals; the general lines that characterize them are the following:

- ✓ They are waters exclusively of underground origin: they can come from a natural emergency or from wells;
- ✓ the chemical composition and temperature must not undergo significant variations over time

Only some treatments are allowed (the same allowed for mineral waters), including: removal of arsenic, separation of unstable compounds of iron, manganese and sulphur, total or partial elimination of carbon dioxide and the possibility of reintroducing it later.

The values of the composition parameters and the contaminating substances must comply with the limit values indicated for drinking water (Italian Legislative Decree 31/01);
The microbiological parameters, on the other hand, must comply with the provisions of the D.M. 12/11/1992 no. 542 for mineral waters.

Spring Waters

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As for the labels on the containers, for the spring waters unlike natural mineral waters, it is not mandatory to report the chemical composition ... (.. this makes it impossible to check the analytical correspondence)

For spring waters, the recognition of the Ministry of Health is expected, but not the evaluation on the pharmacological, clinical and physiological level:
properties favorable to health cannot be attributed to these waters.

As far as the capacity of the containers is concerned, there is no limit for spring waters (they are often packaged in 18.9 liter "boccioni"), while for mineral waters the containers cannot exceed the capacity of two litres.

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Grazie