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ANM REPORT AND RECOMMENDATIONS

Report on the labelling of packaged waters (Referral to the French Health Department - DGS - dated June 16, 2021)[6]

Report on the labeling of packaged waters

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KEYWORDS
Natural mineral water ;
Packaged waters;
Spring waters ;
Drinking water;
Bicarbonate;
Sulfate ;
Fluorine

Summary Some packaged waters, mainly natural mineral waters (NMS) and spring waters, may have a mineral content that causes clinical effects worth mentioning for consumer information purposes. The diuretic effect is linked to the volume of water and the speed ingestion, but minerals are unlikely to play a concrete role, so there is no reason to mention them. Bicarbonate waters (from 600 mg/L hydrogencarbonate) facilitate digestion by acting on gastroduodenal transit and hepatobiliary functions. Sulfated waters (from 200 mg/L in adults and 140 mg/L in children) are likely to accelerate intestinal transit and have a laxative effect, which is enhanced if the waters are rich in magnesium (from 50 mg/L). These effects should be mentioned. Fluoride deficiency leads to dental caries, which can be prevented by fluoridating drinking water within the limits set by international recommendations, without any deleterious effects on teeth or bones. Excessive fluoride intake leads to a deterioration in the structure and quality of teeth and skeleton. An intake

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It has not yet been determined what additional fluorine intake would be beneficial to bone health. Daily intakes should not exceed 0.05 mg/kg body weight per day. Infants and young children should not consume water with a fluoride concentration exceeding 0.3 mg/L if they are receiving medical fluoride supplementation. The essential physico-chemical composition of all water intended for human consumption must be clearly communicated to consumers. Beverages prepared from packaged waters and containing nutrients of other kinds must carry nutritional information suitable for consumption at various stages of life. Water that has been made drinkable by treatment may be exposed to mineral deficiencies that have yet to be fully assessed. Long-term consumption of packaged water, particularly EMN, should t be approved by the treating physician.
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KEYWORDS
Natural mineral water;
Packaged water;
Spring water;
Drinking water;
Hydrogenocarbonate;
Sulfate;
Fluoride

Summary Packaged waters, mainly natural mineral waters (NMW) and spring waters, may have a mineral content causing clinical effects which deserve to be mentioned for the information of consumers. The diuretic effect is related to the volume of water and the speed of ingestion, but minerals are not likely to play a concrete role; so there is nothing to mention. Bicarbonate waters (from 600 mg/L of hydrogen carbonate) facilitate digestion by acting on gastroduodenal transit and hepatobiliary functions. Sulfated waters (from 200 mg/L in adults and 140 mg/L in children) are likely to accelerate intestinal transit and have a laxative effect which is increased if the waters are rich in magnesium (from 50 mg/L). These effects must be mentioned. Fluoride deficiency leads to dental caries that fluoridation of water for human consumption within the limits set by international recommendations can prevent without dental or bone deleterious effects. An excessive intake of fluoride leads to an alteration in the structure and quality of teeth and the skeleton. An additional intake of fluoride that would benefit bone health is not determined at this time. Infants and young children should not consume water with a fluoride level greater than 0,3 mg/L if they are receiving medical fluoride supplementation. The essential physicochemical composition of all water intended for human consumption must be communicated to consumers in a legible manner. Beverages, prepared from waters (NMW, spring waters) and the addition of other nutrients, must carry nutritional information suitable for consumption at different stages of life. Water made drinkable by treatment can expose to mineral deficiencies that are still poorly assessed. Long-term consumption of packaged water, natural mineral water particularly, would not be approved by the attending physician.
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Water is the main constituent of the human organism (60% of body mass in adults), and a perfect balance between water intake and output is essential for good health. Water intake comes from beverages, raw or cooked foods and, to a small extent (300 ml/d, on average), from endogenous water resulting from the oxidation long lipid chains. This latter type of intake is essential for animals living in desert areas (dromedary humpback). Needs vary according to age, circumstance and occupation, but in all cases intake must ensure correct hydration of the body and sufficient diuresis to protect the kidneys. In children, there are classic rules governing the volume of water to be taken in according to weight; the daily quantity of water for children weighing over 20 kilos must not exceed 2400 mL. In adults, intake should be adjusted to ensure a daily diuresis volume of ideally 1.5 L, and never less than 1 L. In the case of urinary lithiasis, a daily diuresis of 2.5 L should be maintained. The volume of water to be ingested also depends on the extent of water losses increased by heat, reduced air humidity and muscular exercise. These environmental conditions determine water through the skin and respiratory tract (thermal polypnoea in dogs).

Over the last few centuries, the quantity water consumed by humans has apparently decreased, while water quality has improved. Today, thanks to technical progress and the application of national [1-3], European [4,5] and global [6] quality standards, the water supplied by public distribution networks in many countries has never been of such high quality. Paradoxically, the growing consumption packaged water (natural mineral water - NMW -, spring water, water made potable by treatment) as drinking water is a worldwide fact [7]. In France, over eight billion liters of such water are sold every year. This phenomenon is mainly based on notions of palatability, convenience and lack of confidence in mains water, with the fear of drinking contaminated water when served in an open carafe; health benefits in general and/or specific to various organs are rarely invoked; the plastic container is not usually considered harmful to health (it is true that plastic water bottles do not contain bisphenol A) but to environment through the carbon footprint of the

transport and accumulation of waste in the oceans [8]. Numerous studies have examined the composition of still and sparkling mineral waters, as well as mains water [2,9,10-13]. In recent years, the Académie has examined the problems of packaged water [14] and, more generally, water intended for human consumption [15]. Our purpose here is not to repeat these earlier reports, which are still relevant, but to provide well-founded answers to the questions posed by the Direction géné- rale de la santé (DGS), which are reproduced in Appendix I and concern labelling statements such as "Contains more than 0.3 mg/L fluoride: not suitable for infants for regular consumption in the event of medical fluoride supplementation", "Stimulates digestion", "May promote hepatobiliary functions" or similar,
"May be laxative", "May be diuretic".

General

Packaged water

Strictly speaking, in addition to natural mineral waters (MNEs) (Appendix II), these include spring waters and drinking waters. Also included are MNEs distributed freely in public refreshment areas at certain spas and taken away, often in large quantities, by consumers, as well as flavored and supplemented waters, most often prepared from MNEs. Bottled MNEs sold in distribution channels are also concerned by the referral, as they the only ones to be the subject of studies likely to identify the clinical benefits and undesirable events linked to the presence of mineral elements, the quantity of which is measured on the dry residue obtained after heating to a temperature of -25°C.
180° C. It is these effects that deserve to be mentioned in the information due to the consumer and whose main
support is the label.

Natural mineral waters

Natural mineral waters (EMN) are underground waters of stable physico-chemical composition, free from contamination (microbial, physical, chemical, . . .). They are subject to legal protection measures, in particular for the perimeter of the spring catchment area. They are used in spa establishments; some are distributed in public refreshment areas. They may be bottled for sale, with labelling that may or may not mention a health benefit. Their therapeutic properties have been the subject of recent therapeutic trials and reviews [16,17].

MNEs are the product of two major hydro-geological systems. In the cold system, meteoric waters and/or marine residues infiltrate soils, circulate by gravity and, over time, loaded with minerals (mainly bicarbonates, sulfates, sodium, silica, calcium, magnesium, chlorides, etc.), eventually heating up on contact with rocks. The waters of the hot system are of magmatic origin, primary metamorphic waters, which may contain various ions (silicon, sodium, chlorides, sulfates), gases (CO_2, H_2S, CH_4) and metals. (lead, zinc, silver. . .) [18]. MNEs used as drinking water are essentially of meteoric origin.

Classification is based on their:

- temperature emergence ;
- hardness assessed by the concentration of calcium ;
- the importance of their mineral content measured on the dry residue at 180° C, but it should be noted that tap water can have an appreciable mineral content [7] ;
- physico-chemical composition involves temperature, pH, calcium, magnesium and sodium ions,
  potassium, chloride, sulfate, bicarbonate, sulfide, iron, manganese, fluorine, etc., soluble silica expressed as SiO2, dissolved gases (H2S, CO2, O2), deposits or suspended solids (Table 1).

Spring water

These are ground waters, like MNEs, but generally with a low mineral content, whether or marketed under the name of the spring, and whose composition appears on the label. They are often distributed under generic brand names such as Aquarel® and Cristaline® . In this case, they usually come from different sources, each with its own composition; the name of the source and composition are identified on the label. Their composition should be carefully examined, as some of these waters may contain high concentrations of minerals or may be recommended for paediatric use.

Water made drinkable by treatment

These are ground waters, sometimes network waters, which treatments similar to those used for network waters in order to "potabilize" them. Some of these waters are prepared and packaged by major international companies, but have little presence on the French market. Some public drinking water distribution networks are implementing similar approaches. Seawater desalination is a comparable approach. If reverse osmosis treatment is used, the water may be over-purified and its mineralization depleted, despite the addition of minerals. The possible risk of mineral deficiencies in water treated in this way has not yet been fully assessed, but the risk of calcium and magnesium deficiencies has been raised for several years [19].

Flavored and supplemented waters

Often referred to as "drinks", they are prepared EMN or spring water. They make up a growing proportion of the beverages sold in our country, given the size of the shelves devoted to them in food stores. Identified as "non-alcoholic soft drinks", they come under the jurisdiction of the Directorate-General for Competition, Consumer Affairs and Fraud Control (DGCCRF). They are therefore the responsibility the Ministry of the Economy, not the Ministry of Health. As such, they are labelled in the same way as foodstuffs, with an emphasis on the proportions of the various nutrients and the calorific aspect, which depends mainly on added carbohydrates, which explains their generative role.

Table 1 Physico-chemical facies of the main types mineral water.

Qualification of water temperature	Wat er	Wat er	Wat er	Wat er
T° C at source	Cold	Hypothermal	Mesothermal	Hyperthermal
	< 20	20-30	30-40	> 40
Hardness	Very soft	Sweet	Hard	Very hard
($CaCO_3$ in mg/L)	0-100	100-200	200-300	> 300
Mineralization	Very low	Low	Average	Strong
Total[a] - mg/L	< 50	50-500	500-1500	> 1500
Ions	Bicarbonate	Sulphated	Chlorurea	Sulfurized
preponderant	≥ 600	≥ 200	≥ 200	Presence of H_2S
mg/L	Calcium	Magnesian	Fluorinated	Ferruginous
	≥ 150	≥ 50	≥ 1	Fe^{++} (0.5-5)
	Sodium	Low sodium≤ 20	Acid	
	≥ 200mg		CO_2≥ 250 mg/L	

[a] From the dry residue obtained after heating to 180 C.°

obesity. The reference values quoted are those for adults only, whereas they are widely consumed by children and teenagers. What's more, the physico-chemical composition of the water from which they are prepared is not indicated on the label. They may therefore contain certain minerals, the quantity of which is likely to produce effects that should be indicated the label. France's Public Health Code, translating a European directive, imposes quality criteria for water "intended for human consumption", whether distributed by network or packaged (spring water, water made potable by treatment) and for MNEs. There are also enforceable standards for water intended for infants (Table 2).

The method

The content of this report is based on a review of data from the literature, mainly controlled clinical studies, observational studies, reviews... .

The commission also gathered expert opinions during nine hearings, which included members of the Académie (Prs Ardaillou, Bourre, Buffet, Charpentier, Géraut, Hascoët, Hubert), external members (Pr C. Roux, Hôpital Cochin), spa doctors (Dr Faure Imbert, Châtel-Guyon; Dr Duprat, Capvern and Dax; Dr Guérin, Vichy; Dr Ourérin, Vichy), as well as members of the Académie's own staff. Roux, Hôpital Cochin), spa doctors (Dr Faure Imbert, Châtel-Guyon; Dr Duprat, Capvern et Dax; Dr Guérin, Vichy; Dr Oury, Vittel), and representatives of the Conseil national des établissements thermaux (M. T. Dubois, M. C-E. Bouvier) and the Société fran¸caise de médecine thermale et hydrologie (Pr G. Kanny, Dr K. Dubourg).

In the following lines, the commission endeavors to provide well-founded answers to the specific and concrete questions posed by the DGS. In a final chapter, the commission shares observations that have emerged in the course of its work, and which it feels merit inclusion in this document.

Review of terms submitted to the Academy for approval

May be diuretic

Findings: the physiology of diuresis

Physiological diuresis is aqueous and due water intake. Drinking decreases plasma osmolarity and increases plasma volume, leading to inhibition of vasopressin secretion and thus diuresis. Vasopressin, secreted in hypothalamus, binds to V2 receptors in the distal convoluted tubule and collecting tubule. The 2th mes- sager cyclic AMP, which causes water channels (type 2 aquaporins) to migrate [20], resulting in an osmotic gradient of water transfer to plasma. This process is inhibited during aqueous diuresis, as V2 receptors are no longer stimulated. There are clinical situations (diabetes insipidus, renal or pituitary diabetes, potomania) where vasopressin secretion is dimi- nished, leading to impaired water reabsorption and increased diuresis. Conversely, vasopressin secretion is increased in the Schwartz-Bartter syndrome of small-cell bronchial cancer, generating water and hyponatremia by dilution.

Osmotic diuresis is due to a difference in osmotic pressure between urine and blood in the peritubular capillaries, with the former exceeding the latter. Since water transfer is passive, the water present in the urine, which is no longer reabsorbed, is excreted. Thus, glucose filtered at its maximum level (Tm) is no longer reabsorbed, due to the lack of a sodium-glucose co-transporter in the distal nephron; it then flows into the urine, leading to osmotic diuresis, the cause of polyuria in diabetes mellitus. Osmotic diuresis is also observed after administration of filtered, non-reabsorbed substances (mannitol).

Table 2 Water quality limits - main chemical parameters.

Substance	Rate (EU 2020)[a]	EMN[b]	Infants[c]
Aluminum	200 µg/L		200 µg/L
Antimony	10 µg/L	5 µg/L	5 µg/L
Arsenic	10 µg/L	10 µg/L	10 µg/L
Barium	1 mg/L	1 mg/L	0.7 mg/L
Boron	1.5 mg/L		0.3 µg/L
Bromates	10 µg/L		3 µg/L
Cadmium	5 µg/L	3 µg/L	3 µg/L
Calcium	NA		100 mg/L
Chlorides	250 mg/L		250 mg/L
Chrome	25 µg/L	50 µg/L	5 µg/L
Copper	2 mg/L	1 mg/L	0.2 mg/L
Cyanides	50 µg/L	70 µg/L	10 µg/L
Iron	200 µg/L	NA	NR
Fluorine	1.5 mg/L	5 mg/L	0.5/0.3 if supplementing F
Magnesium	NA	NA	50 mg/L
Manganese	50 µg/L	500 µg/L	50 µg/L
Mercure	1 µg/L	1 µg/L	1 µg/L
Nickel	20 µg/L	20 µg/L	2 µg/L
Nitrates	50 mg/L	50 µg/L	10 mg/L
Nitrites	0.5 mg/L	0.1 mg/L	0.05 mg/L
Lead	5 µg/L	10 µg/L	10 µg/L
Selenium	20 µg/L	10 µg/L	10 µg/L
Sodium	200 mg/L		200 mg/L
Sulfates	250 mg/L		140 mg/L
Uranium	30 µg/L		
Zinc	NA		0.10 mg/L
Total pesticides	0.50 µg/L		0.1 µg/L

[a] Water intended for human consumption: spring water and water made drinkable by conditioned treatment (EU 2020).
[b] Natural mineral water. We present the rates applicable in our country (France, decree of March 14, 2007, version June 2021; EU, 2009).
[c] France 2015 (Annex IV of the decree of March 14, 2007, version in force in June 2021).

An osmotic effect, linked to a particular mineral, could only be observed with mineral water containing a very high concentration of mineral salts, with little or no reabsorbability, which is not the case with EMN and other packaged waters used as drinking water. Furthermore, the reduction in aldosterone secretion after ingestion of bicarbonated water observed by some authors [21,22] does not appear to have been confirmed. It therefore appears that the diuresis associated with the ingestion of packaged water (mineral, spring . . .) is aqueous and linked to the volumes of liquid absorbed and, in part, to the nycthemeral cycle of AVP secretion. These various data [23,24] confirm previous knowledge [25].

In conclusion, the various bottled mineral waters therefore result in aqueous diuresis. As such, all these waters are "diuretic" in terms of the volume of liquid they provide.

Recommendations

EMN and other packaged waters generate aqueous diuresis conditions. Affixing a "may be diuretic" label to a particular type natural mineral water, spring water or other packaged water is not based on current data on the physiology of diuresis.

Fluorine statement: "Contains more 0.3 mg/L fluorine: not suitable for infants for regular consumption in the event of medical fluoride supplementation".

Findings

Fluorine's affinity for calcified tissues (bone and teeth) is explained by the fact that it can substitute for the hydroxyl of hydroxyapatite, resulting in a fluoroapatite molecule [26]. Fluorine plays a fundamental role in the prevention of dental caries [27], in the form fluoride ions, during the formation of calcium fluoroapatite in tooth enamel and bone for good quality. Applied topically (toothpaste, fluoride gel), fluoride promotes enamel mineralization and reduces plaque by inhibiting the reproduction of cariogenic bacteria. In certain cases, local application of fluoride can reduce dental hypersensitivity and stop caries lesions by stimulating remineralization.
sation. But they are harmful:

- ingestion of toothpaste by children unable to rinse their mouths;
- systematic overdosing with hyperfluorinated toothpastes;
- the multiplication of poorly controlled food sources.

Dental lesions were described early on [28], but in 2010 the WHO declared them a major public health problem: "Fluoride is one of ten chemicals posing a major public health problem, alongside other toxic substances such asbestos and arsenic". Excess fluoride in children leads to the appearance of whitish or brown stains on tooth enamel. There is no treatment for this condition [29-31], which is rare at water fluoride concentrations below 2 mg/L (Lennon et al., 2004); however, the current trend is to set the upper limit at 0.7 mg/L to avoid this type of lesion [30].

Bone fluorosis is linked to the excessive accumulation of fluoride, causing changes in the structure bones, which become more fragile and brittle. Fluorosis lesions manifest as diffuse ligamentous and bony condensation affecting the spine, pelvis and thorax, associated with calcifications of ligaments and interosseous membranes. These findings are corroborated by observational data in both animals and humans.

In sheep, calcium-poor, fluoride-rich water reduces bone mass, impairs bone quality and leads to fatigue fractures [32]. In female rats, consumption of poorly mineralized water over several generations resulted in impaired bone quality [33].

Human bone fluorosis, with changes in bone structure and mineralization, is observed for water concentrations ranging from 3 to 6 mg/L, but overall this risk is low below 4 mg/L according to the WHO [34]. Studies carried out in China and India show that exposure to a dose of 14 mg/d is associated with an excess risk of bone fluorosis [34]. A significant increase in the prevalence of bone fractures was observed in a population 8,266 Chinese subjects regularly consuming water containing between 4.3 and 7.9 mg/L [35]. There is a risk of skeletal fluorosis for total fluoride exposure in excess of 6 mg/d.

A Chinese study showed that fluoride supplementation fluoride-poor waters was accompanied by a normalization of urinary fluoride concentration, serum calcitonin and osteocalcin, the most sensitive markers of bone remodelling [36]. Previously, it had been observed that fluoridation of drinking water in the USA was not associated with a significantly increased risk of fracture [37]. Drinking water fluoridation has not been shown to reduce the risk of femoral neck fractures, and it is uncertain whether additional fluoride intake is beneficial to bone health [30,38]. In addition, sodium fluoride, administered at a dose of 10 to 20 mg per day for several months, as a treatment osteoporosis, increased bone mass but had no impact on the occurrence of fractures.

Lastly, the risk osteosarcoma once suggested has not been confirmed [30].

A recent review [39] confirms that, in addition to its effects on calcified tissues, fluorine's neurotoxic action must taken into account. This affects cognitive functions, producing memory and memory disorders. of children exposed to excessive levels. Neurotoxic phenomena are due to the cellular inflammatory damage, through lipid peroxidation, induced by excess fluorine. They occur both during intra-uterine life and after birth. The intellec- tual impairment observed is an average loss of 8 points when measuring intelligence quotient (IQ), per additional milligram of fluoride contained in the water. These phenomena may be underestimated, as most epidemiological studies have only been carried out on subjects exposed to high doses of fluoride, whereas they have also been observed for fluoride concentrations in water of 0.5 to 1 mg/L, although no threshold can be set, due inputs of other kinds.

Fluoride is mainly supplied by food and water. Dietary intake is relatively fixed for an adult, whereas water intake can vary according to the fluoride concentration in the water [40]. The fluoride concentration in breast milk is particularly low, and does not pose a risk of fluorosis [40]. Fluorine is eliminated mainly via the urine, so in populations with no occupational exposure, the urinary concentration should not exceed 1 mg/g of urinary creatinine [41]. The recommended dietary intake of fluoride from all sources (including non-food sources) is 0.05 mg/kg body weight per day for children and adults, including pregnant women and nursing mothers [40]. The concentration not to be exceeded is 1 milligram per day for children and 4 milligrams per day for adults. The Cochrane Collaboration does not consider fluoridation of children's milk to be a proven, risk-free solution [42].

In France, in accordance with European regulations, fluoride concentrations must not exceed 1.5 mg/L for water intended for human consumption, and 0.5 mg/L and 0.3 mg/L for water consumed by infants and children under 1 year of age, if infants and young children up to 12 months of age are receiving fluoride supplements. The authorized concentration for EMN is 5 mg/L. According to the WHO [30], a concentration of 0.7 mg/L is sufficient to prevent the deleterious effects of fluoride deficiency and protect children from dental fluorosis. Canadian paediatricians are in favour of supplementation fluoride levels are below 0.3 mg/L (CPS: Canadian Paediatric Society, 2021) [43]. There is therefore little room for manoeuvre in children.

Recommendations

In short, fluoride is necessary for healthy teeth, but it can also have hormenetic effects. Fluoride deficiency leads to tooth decay, which can be prevented by fluoridation of drinking water (and possibly cooking salt) within the limits set by international recommendations, without any deleterious effects on teeth or bones. Excessive fluoride intake leads to a deterioration in the structure and quality of teeth and skeleton. It has not yet been determined whether additional fluoride intake would be beneficial to bone health. Excessive fluoride intake also has deleterious effects on children's nervous systems, impairing their ability to function.

from the very beginning of intra-uterine life. Our knowledge of these effects is still evolving, and could lead an upward re-evaluation of these effects and, consequently, to possible revisions of the levels to be respected. Daily intakes should not exceed 0.05 mg/kg body weight per day.

The label "Contains more than 0.3 mg/L fluoride: not suitable for infants and young children for regular consumption in case of medical fluoride supplementation" is therefore scientifically justified.

Digestive information: "Stimulates digestion", "May promote hepatobiliary functions" or a similar statement, "May be laxative".

Findings

Some bottled waters loaded with mineral salts can act on the digestive tract (stomach, duodenum, intestine) and bile ducts. These include, in particular, bicarbonated and sulfated waters. Table 3 shows the physico-chemical composition of the waters used in the studies cited in this chapter.

On the clinical front, in 2007, a sequential clinical trial involving 39 patients showed an improvement in an overall functional dyspepsia score in patients who had undergone a two-week drinking course (200 to 300 ml of sulfated water).

and calcium-magnesium bicarbonate at 33˚ C) [44]. More recently, improvements in constipation have reported chronic constipation after drinking sulfated magnesian water [45,46]. In 106 healthy subjects suffering from functional constipation, the administration of 300 or 500 mL of sulfated (2000 mg/L) sodium (1600 mg/L) and magnesium (1000 mg/L) water for 6 weeks, compared with sparkling water low in minerals but with a comparable amount of CO2, increased bowel movements, improved stool consistency and reduced the per¸cus symptoms of constipation [47]. A recent review confirms these various elements [48]. These waters fall into the category of osmotic laxatives, the most widely used in cases of chronic constipation, in comparison with lubricant, stimulant or ballast laxatives.

Carbonated water without significant mineral content creates a feeling of satiety and promotes gastric function [49]. Sodium bicarbonate water increases gastric secretion and emptying without altering mucus qualities or gastrin secretion [50]. It is thought to reduce vesicular emptying when taken with a meal [51]. Finally, one study compared drinking calcium-phosphate bicarbonate mineral water with drinking local tap water; mineral water reduced the risk of vesicular lithiasis and contributed to weight stability in patients who ate more than tap water drinkers [52]. Sulfated calcium or magnesium bicarbonate water is said to have a choleretic and cholagogue action, and to act on vesicular hypomotility [53,54]; the choleretic carac- ter is confirmed by a more recent study, which shows a decrease in alkaline phosphatase, gamma-glutamyl-transferase and bilirubin [55].

In summary, controlled studies show that consumption 0.5 to 1 L bicarbonated water providing at least 300 to 400 mg of bicarbonate over 24 hours improves digestion by promoting i) gastric emptying, ii) secretion of digestive hormones; iii) has a cholagogue and choleretic action. These waters seem particularly useful for dyspepsia of gastric origin and/or linked to functional disorders of the bile ducts. The only adverse effect of strong bicarbonate waters is excessive sodium intake in hypertensive subjects and those with heart failure.

Sulfated water (at least 200 mg sulfates per L) can classically have a laxative effect in subjects no digestive disorders. In adults, it acts on intestinal transit by increasing the quantity of water in the stools through osmotic phenomena and their effect on aquaporins in the intestinal epithelium [56]. However, the effect on intestinal transit is not evident at these levels [57,58]. Daily sulfate intake is mainly provided by food, averaging 500 mg [6]. Consumption of sulfated water adds to this sulfate intake. The concentration of 500 mg/L is, moreover, the average threshold for taste detection the sulfate ion [57]. summary of clinical studies shows that daily administration of 1 liter of sulphated water for one month, providing 0.5 to 1.5 g of sulphate and 100 mg of magnesium, is an effective treatment for adult constipation as an osmotic laxative.

While sulfates cause osmotic diarrhea in adults, colitis and gastroenteritis have been observed in children [58,59]. For an infant, sulphated water considered to be water with a sulphate content exceeding that of breast milk (140 mg/L) [57].

Magnesium stimulates intestinal peristalsis [53] and may cause diarrhoea or abdominal pain, which are listed under adverse events for oral dosage forms. Insofar as its laxative effect is still being tested in sulfated mineral waters, it is difficult to determine the respective weight of each of these ions in the occurrence of diarrhea or the improvement of constipation. Whatever the case, the actions of sulfate and magnesium ions are mutually reinforcing. Their synergy promotes hydration of the faecal bolus, cholecystokinin secretion and choleresis [53].

Purgation using sulfates usually requires the administration of five grams of sulfates in an adult [59]. For colonic preparations, the purga- tive doses administered range from 15 to 30 g of sulfates, according to the data provided in the leaflets, and are more effective than polyethylene glycol-based preparations [60]. It is unlikely that these doses can be achieved with packaged waters.

Sulfated bicarbonate waters act on the pain of gastric dyspepsia [44,61] and irritable bowel syndrome [61], on the risk of biliary tract lithiasis [52] and have a choleretic and cholagogue action [53]. Magnesium sulfate waters also have an effect on hepatobiliary function [54].

The waters tested in the Italian studies were often both bicarbonated and sulfated (Table 3).

Table 3 Mineral waters tested in clinical studies cited.

Study (year)	pH	Minerals (mg/L) Dry 180 C°	CO2	Na mg/L	Mg mg/L	Ca mg/L	SO4 mg/L	HCO3 mg/L	Cl mg/L	Remarks and chemical qualification
Dupont 2014	7,2	2600		14,2	**119**	**549**	**1530**	383,7		Hepar water Sulphated calcium, magne-sienna
Naumann 2016		2666	2652		**105**		**1535**			Magnesium sulfate water
Bothe 2017			3500	1600	**1000**	**370**	**2000**	**7600**		Sulfated, bicarbonated, calcium, magnesium
Bertoni 2002	6	986	820	113,7	29,8	202	151	**683,2**	121,4	Pure bicarbonate
Corradini 2011	6,8	3280	537	41	**180**	**840**	**1840**	**730**	29,4	Sulfated, bicarbonated, calcium, magnesium
Toxqui 2012			3900	**1102**	9,4	32	45,3	**2120**	11	Bicarbonate sodium
Rocca 2007	6,8	3280	537	41	**180**	**840**	**1840**	**730**	29,4	Sulfated, bicarbonated, calcium, mùagnesian
Fraioli 2010	6,8	3280	537	41	**180**	**840**	**1840**	**730**		Aqua santa Sulfated, bicarbonated, calcium, magnesium
Id°			98	24,4	**79,8**	**630**	**1430**	494	30	Fucoli - sulfated calcium, magnesium
Wakisaka 2012			3.25bars	10,7	4,7	29,8	0	CaCO3 94		Sparkling water no mineralized
Mennuni 2014			98	24,4	**79,8**	**630**	**1430**	494	30	Fucoli - sulfate, calcium, magnesium
Dore **2021**	6,23	2808		550	46	145	**295**	**1305**	339	Sulfate bicarbonate

NB: concentrations meeting or exceeding qualification standards for a particular facies shown in bold.

Table 4 Composition of some of the natural mineral waters consumed in France.

	VICHY Célestins	VALS	CHATELDON	PERRIER	BADOIT	HYDROX-YDASE	EVIAN	CONTREX	VITTEL	HÉPAR
pH	6,5	6,4	6,2	5,5	6	6,8	7,2	7,4	7,8	7,2
CO2	NR	NR		NR	NR	2747				
Total mg/L (dry residue 180 C)°	3325	1629	1882	456	1100	9657	488	2056	1073	2600
Sodium mg/L	1172	381	240	9,6	180	1860	6,5	9,4	5,2	14,2
Calcium mg/L	103	222	383	150	153	213	80	468	240	549
Magnesium mg/L	10	13,5	49	3,9	80	243	26	74,5	42	119
Sulfate mg/L	138	45	20	25,3	35	10,8	14	**1121**	**400**	**1530**
Chloride mg/L	235	24.6	7	19,5	44	367		7,6		
Bicarbonate mg/L	**2989**	**1100**	**2075**	420	**1250**	**6722**	360	372	384	383,7

NB: concentrations meeting or exceeding qualification standards for a particular facies shown in bold.

This is less often the case in France (Table 4). Moreover, the fizzy character associated with the presence of carbon dioxide in water may help to improve digestive trans- sit, confirming long-standing empirical observations that have led to the manufacture of effervescent pharmaceutical forms for the administration of certain drugs. It also appears that fran¸cais bottlers of sparkling mineral water do not usually indicate the gas content of their waters.

Recommendations

The claim "Stimulates digestion" can be applied to bicarbonated waters at the 600 mg/L concentration that bicarbonated waters.

The statement "Possible laxative effect" may be justified for sulfated waters in adults at a concentration of 200 mg/L, since diarrhea has been reported to occur at these concen- trations. For children, a concentration of 140 mg/L should be used to grant the label.

"In addition, this is the upper limit for use in infants. The occasional use of sulfated water to constipation children must be prescribed by a doctor, pediatrician or general practitioner.

The impact of bicarbonate, sulfate-bicarbonate and sulfate-magnesium waters on hepatobiliary function has a more limited level of evidence. The statement "may promote hepatobiliary functions" is not currently based on robust data. Pending further evidence, we may postpone granting the proposed claim and/or propose a claim "may promote hepatobiliary functions".

General comments

The wording of the information

Given the ambiguity of the term "may be", which is easily confused with "perhaps", wouldn't it be preferable to use a more unambiguous term: "possible x effect" or "possible x effect"?
"may cause effect x".

Labeling

All bottled waters (EMNs, spring waters, drinking waters, flavored waters) must include their essential physicochemical composition on the label, as well as any indications that certain mineral elements may justify in terms of benefits or adverse events. This information must be made easily legible by using an appropriate font size and character/background contrast.

The same should apply to EMN's public refreshment areas, especially those with free access.

Flavoured waters should mention i) the mineral compo- sition and, where appropriate, the justified indications ;
ii) the percentage nutritional intake recommended not only for adults but also for children.

The obligation to inform consumers about the quality of water distributed for human consumption justifies making the physico-chemical composition public, beyond the simple safety parameters usually identified.

Water intended for consumption by children

Findings

Children, because of the vulnerability of some of their organs or systems to inappropriate levels of minerals, require special attention that goes beyond water quality when preparing baby bottles from formula milk powder.

The texts in force in this country (decree of December 9, 2015, listed in Appendix IV of the decree of March 14, 2007, version currently in force), the standards used in other countries, the standards recommended at international or global level, and the data in the literature provide a clearer picture of the quality standards for packaged water intended for children, beyond the fluoride and sulfate concentra- tions mentioned above.

There may be multiple considerations in relation high water requirements, kidney immaturity, endocrine disruptors in plastic containers, a fragile hydro-electrolytic balance (sodium, calcium, phosphorus, etc.), and the potential presence of microorganisms, pesticides and other inputs.

The total mineralization retained by French regulations is 1000 mg/L of water, whereas Canada has more recently retained a total mineralization of 500 mg/L which must not be exceeded [62].

The lead problem is well known, but the concentration currently used in France is twice that used in Canada, which seems preferable; the evolution of regulations in European Union does not foresee definitive compliance with this concentration until 2036.

In the first six months of life, iron intake must be controlled, but thereafter, the iron requirements of the haematopoietic system increase, so that the current concentration of 0.2 mg/L can be safely replaced by 0.3 mg/L [63].

Molybdenum is an important enzymatic cofactor for several oxidase systems (sulfites, xanthine, aldehyde); [6].daily requirements for adults are estimated at 0.1-0.3 mg/day [6], while the WHO [63] guideline of 0.007 mg/L for water remains unchanged

Perchlorates cause thyroid and pituitary disorders [6,64]. Their concentration must not exceed 0.004 mg/L in water intended for children under six months of age.

Sulfites are used as food preservatives and anti-browning agents. They can be the cause of allergic phenomena (asthma and urticaria in particular) [65], or even anaphylaxis, photosensitization, headaches and also neurotoxicity [66]. . . They are not usually found in water, which explains why they are not identified in reference texts on water [6]. However, they can be found in fruit juices and syrups, which can be used to make flavored drinks. Canada proposes a concentration of 0.05 mg/L of beverage not to be exceeded [62].

The absence pathogenic micro-organisms, pesticide inputs (total pesticides detected and quantified), below detection limits [62].

Thus, children should only consume bottled, non-carbonated water that meets the criteria of current French regulations, but incorporates the elements identified below, the levels of which must be adapted in line with data from the literature and certain international or foreign experiences.

Recommendations

Water intended for children should incorporate the following quality parameters in place of the criteria identified in current regulations.

Complements: total dry mineralization less 500 mg/L, sulfites less than 0.05 mg/L, lead less than 0.005 mg/L, iron less than 0.3 mg/L, molybdenum less than 0.07 mg/L.

Microbiology: no pathogenic microorganisms per 100 mL.

Inputs: absence of pesticides (total pesticides individualized, detected and quantified), benzyl derivatives, hydrocarbons, tetra or trichloroethylene (within detection limits).

Perchlorates: less than or equal to 0.004 mg/L.

Conclusion

In developed countries, bottled water is an increasingly important consumption habit, despite the excellence of water for human consumption distributed by public networks.

The presence of mineral elements can have beneficial and/or deleterious effects on the health of the people who consume these waters, particularly when consumed over the long term.

This information is useful protecting consumer health. However, as each clinical situation is unique, the long-term consumption of packaged water, particularly EMN, must be approved by the attending physician.

The essential physico-chemical composition all water intended for human consumption must be communicated to consumers.

In addition, when beverages prepared water (EMN, spring water) are marketed after the addition of other nutrients, nutritional information must be adapted to consumption at various stages of life.

Water made drinkable by treatmentif excessively purified by reverse osmosis and insufficiently remineralized, can expose you to mineral deficiencies that have yet to be fully assessed.

Declaration of interest

The authors declare that they have no ties interest.

Online supplement. Additional material

Supplementary material accompanying the online version of this article is available at http://www. sciencedirect.com and https://doi.org/10.1016/j.banm.2022 .03.003.

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