Lamter Labs

Determination of Conductivity from Monster Original, Monster Zero Ultra White and Monster Mango Loco

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1. Introduccion

Electrical conductivity measures how well a substance transmits an electric current. In solutions, this capacity depends directly on the presence of dissolved ions, which are generated when electrolytes (such as salts, acids, or bases) dissolve and dissociate into charged particles. Common examples include sodium chloride, hydrochloric acid, and sodium hydroxide (Electrochemistry, 2022)[1].

The ions most responsible for conductivity are calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), chloride (Cl^-), sulfate (SO_4^{2-}), bicarbonate (HCO_3^-), and nitrate (NO_3^-). Because conductivity reflects the total ionic load of a solution, it serves as a practical indirect indicator of total dissolved solids (TDS) (Atlas Scientific)[2].

Conductivity is a key parameter in assessing the general chemical state of a solution. Elevated values may indicate a high concentration of dissolved substances, which can result from industrial discharges, agricultural runoff, or natural mineral dissolution. On the other hand, very low conductivity is characteristic of highly pure substances but may also imply limited buffering capacity, which can be relevant depending on the intended application (Environmental Measurements Systems)[3].

Conductivity is determined using a conductivity meter, which applies an alternating voltage across two electrodes immersed in the sample. The resulting current is measured and conductivity is calculated by applying Ohm's Law, a purely physical and electrical measurement involving no chemical reactions (Electrochemistry, 2022)[1]. To ensure accuracy, the instrument must be calibrated with certified standard solutions (typically potassium chloride (KCl)) of known conductivity value, which are a standard of 12.88 mS/cm (Hach, Conductivity Standard Solution 12.88)[4] and a standard of 1,413 µS/cm (Hach, Conductivity Standard Solution 1413)[5].

Energy drinks are formulated with a range of dissolved compounds (including sugars, organic acids, vitamins, caffeine, and, most significantly, electrolytes such as sodium, potassium, and magnesium), which are intentionally added to support hydration and physiological performance (CommonSpirit Health)[6], making conductivity a particularly meaningful analytical parameter for this type of product.

Measuring conductivity in an energy drink provides a rapid and reliable indication of its total dissolved solids content. This is relevant for several reasons. First of all, it allows the verification that the ionic composition aligns with the product's formulation specifications, ensuring batch-to-batch consistency during manufacturing. Second, it serves as a quality control tool to detect potential adulteration, dilution, or ingredient imbalances that might not be apparent through visual inspection alone. Third, from a regulatory and consumer safety standpoint, an abnormally high conductivity could suggest an excessive concentration of salts or other dissolved substances, which may pose health risks with prolonged consumption, including electrolyte imbalance complications (Bubs Naturals)[7].

There is currently no single universal regulatory limit specifically established for the electrical conductivity of energy drinks. However, scientific studies provide useful reference ranges for contextualizing measured values. A comparative physicochemical analysis of fourteen energy drink brands found that conductivity values ranged from approximately 2.21 to 1,975 μS/cm (Project Reserve, 2017)[8].

Therefore, a conductivity value falling within this range (from 2.21 μS/cm to 1,975 μS/cm) can be considered acceptable and consistent with commercially available energy drink products. Values significantly exceeding this upper limit may suggest an excessive ionic load, potentially associated with formulation inconsistencies or contamination. Conversely, values below the lower end of this range may indicate a notable deficiency in electrolyte content, which would be inconsistent with the product's intended composition and marketing claims.

2. Risk Prevention

There are no additional risks associated other than the basic laboratory hazards.

3. Procedure

3.1. Samples

- Original Monster (Monster Energy Original Green).
- No Sugar Monster (Monster Energy Ultra White).
- Mango Loco Monster.

3.2. Material

- Beakers
- Conductivity standards
    - Standard of 12,88 mS/cm
    - Standard of 1413 μS/cm

3.3. Experimental Procedure

- Degas the samples, due to CO_2 can affect the measurement.
    - Place each sample on a magnetic stirrer for 5–10 minutes at 700–900 rpm.
- Turn on the conductivity meter.
- Clean the electrode with distilled water and dry it with a paper towel.
- Calibrate the conductivity meter:
    - Immerse the electrode in the first standard solution (1413 μS/cm) until prompted to proceed.

    - Clean the electrode with distilled water and dry it with a paper towel.
    - Repeat the calibration with the standard of 12,88 mS/cm until proper calibration is achieved.
- Clean the electrode again with distilled water and dry it with a paper towel.
- Pour some of the sample into a beaker and immerse the electrode.
- Measure the conductivity and record the results.
- Clean and dry the electrode again.
- Repeat the measurement three times for each sample.

4. Table with Experimental Data

Conductivity	1	2	3
Original Monster	1502 µs/cm	1385 µs/cm	1387 µs/cm
Ultra White Monster	2070 µs/cm	2040 µs/cm	2040 µs/cm
Mango Loco Monster	1306 µs/cm	1307 µs/cm	1298 µs/cm

Table 1. Experimental Data

5. Calculation

- Statistical Analysis
    - Original Monster

Experimentals Data	Average	(x - average)	(x- average)^2	Sd
1502 µs/cm	1425 µs/cm	77	5980	1425 $\pm$ 67 µs/cm
1385 µs/cm		- 40	1573	1425 $\pm$ 67 µs/cm
1387 µs/cm		- 38	1418	1425 $\pm$ 67 µs/cm

Table 2. Statistical Analysis Original Monter

Average: $\frac{1502+1385+1387}{3} =$ **1425**

(x- average):

1502 - 1424,667= **77,333**

1385 - 1424.667= **- 39,667**

1387 - 1424.667= **- 37,667**

(x- average)^2:

77,333^2 = **5980,393**

(-39.667)^2 = **1573,471**

(-37.667)^2 = **1418,803**

DS: $\sqrt{\frac{5980.393+1573.471+1418.803}{2}}$ **= 66,980 µs/cm**

Cv: $\frac{66,980}{1424.667} \times 100 = $ **4.70%**

- Ultra White Monster

Experimentals Data	Average	(x - average)	(x- average)^2	Sd
2070 µs/cm	2050 µs/cm	0,02	0,0004	2050 $\pm$ 0 µs/cm
2040 µs/cm		- 0,01	0,0001	2050 $\pm$ 0 µs/cm
2040 µs/cm		- 0,01	0,0001	2050 $\pm$ 0 µs/cm

Table 3. Statistical Analysis Ultra White Monter

Average: $\frac{2,07+2,04+2,04}{3} = $ **2,05**

(x- average):

2,07 - 2,05 = **0,02**

2,04 - 2,05 = **- 0,01**

Cv: $\frac{0,017}{2,05} \times 100 = $ **0,83%**

(x- average)^2:

$0,02^2$ = **0,0004**

$(-0.01)^2$ = **0,0001**

DS: $\sqrt{\frac{0,0004+0,0001+0,0001}{2}}$ **= 0,017 µs/cm**

- Mango Loco Monster

Experimentals Data	Average	(x - average)	(x- average)^2	Sd
1306 µs/cm	1304 µs/cm	2	5	1304 $\pm$ 4 µs/cm
1307 µs/cm		3	11	1304 $\pm$ 4 µs/cm
1298 µs/cm		- 6	32	1304 $\pm$ 4 µs/cm

Table 4. Statistical Analysis Mango Loco Monster

Average: $\frac{1306+1307+1298}{3} = $ **1304**

(x- average):

1306 - 1303,667 = **2,333**

1307 - 1303,667 = **3,333**

1298 - 1303,667 = **- 5,667**

(x- average)^2:

$2,333^2$ = **5,442889**

$3,333^2$ = **11,108889**

$(-5,667)^2$ = **32,114889**

DS: $\sqrt{\frac{0,0004+0,0001+0,0001}{2}}$ **= 4,028 µs/cm**

Cv: $\frac{4,028}{1303,667} \times 100 = $ **0,31**

6. Results

Sample	Value of Conductivity in µS/cm
Monster Energy Original Green	1425 ± 67 µS/cm
Monster Energy Ultra White (No Sugar)	2050 ± 0 µS/cm
Mango Loco Monster	1304 ± 4 µS/cm

Table 5.Results

7. Conclusions

The conductivity values obtained experimentally for three Monster Energy drink variants, further support and complement the reference range reported in the literature. Monster Energy Original Green yielded a value of 1,425 ± 67 µS/cm, Mango Loco Monster 1,304 ± 4 µS/cm, and Monster Energy Ultra White (No Sugar) 2,050 ± 0 µS/cm. These results fall within or close to the upper boundary of the reported literature range, confirming that the ionic content of these products is consistent with commercially available energy drinks (Atlas Scientific)[2]. The notably higher conductivity observed in the sugar-free variant may be attributed to a greater concentration of mineral salts or acidic compounds used to compensate for the absence of sugar, thereby contributing more ions to the solution (getMTE)[9].
The reference study (Project Reserve, 2017)[8] analyzed fourteen brands of commercially available energy drinks, comprising eleven liquid and three powdered forms, evaluating their physicochemical properties including conductivity, pH, turbidity, and total dissolved solids, as well as trace and heavy metals, sugars, aspartame, and caffeine content. The study reported a conductivity range of 2.21 – 1,975 µS/cm across all samples, with all brands falling within the FDA's recommended range for the physicochemical parameters evaluated. In this regard, the study is directly comparable to the present analysis, as both examine ready-to-consume commercial energy drink products. The use of the same sample type — liquid energy drinks available on the market — lends particular validity to the comparison of conductivity values between both datasets.

From a health perspective, the elevated conductivity values recorded across all three variants reflect a high ionic load that, while expected and functional in the context of energy drinks designed to replenish electrolytes, warrants consideration. Sustained or excessive consumption of beverages with high dissolved ion concentrations may place an additional burden on renal function, particularly in individuals with pre-existing kidney conditions (National Kidney Foundation)[10]. Furthermore, the elevated mineral and additive content suggested by the high conductivity of the sugar-free variant raises questions about the long-term metabolic implications of regular consumption, especially among young consumers for whom these products are heavily marketed (Frontiers in Public Health)[11].

Overall, a conductivity value within the range of 1,304 – 2,050 µS/cm can be considered representative of this type of product. Values significantly exceeding this range may suggest an excessive ionic load, while values well below it may indicate electrolyte deficiency or product dilution. In all cases, conductivity should be interpreted alongside complementary physicochemical parameters — such as pH, TDS, and ion-specific analyses — to draw well-founded conclusions regarding product quality and regulatory compliance (Environmental Measurements Systems)[3].

8. Bibliography

1. Mizuhata, M. (2022d). Electrical Conductivity Measurement of Electrolyte Solution. Electrochemistry, 90 (10), 102011. https://doi.org/10.5796/electrochemistry.22-66111
2. Pomelo. (2024, 5 marzo). Conductivity (EC) vs Total Dissolved Solids (TDS) - What's The Difference? | Atlas Scientific. Atlas Scientific. https://atlas-scientific.com/blog/conductivity-vs-tds/
3. Conductivity, salinity & total dissolved solids - environmental measurement systems. (2025, 24 octubre). Environmental Measurement Systems. https://www.fondriest.com/environmental-measurements/parameters/water-quality/conductivity-salinity-tds/
4. Conductivity Standard Solution, 12.88 mS/cm, KCl, 125mL. (s. f.). https://www.hach.com/p-conductivity-standard-solution-1288-mscm-kcl-125ml/LZW9721.99
5. Conductivity Standard Solution, 1413 µS/cm, KCl, 125mL. (s. f.). https://www.hach.com/p-conductivity-standard-solution-1413-scm-kcl-125ml/LZW9711.99
6. Beyond the Bottle: A Doctor's Take on Energy, Protein, & Electrolyte Drinks | CommonSpirit Health. (s. f.). https://www.mountain.commonspirit.org/story/beyond-bottle-doctors-take-energy-protein-electrolyte-drinks
7. Naturals, B., & Naturals, B. (2025, 19 septiembre). What energy drinks have electrolytes? Exploring your hydration options. BUBS Naturals. https://www.bubsnaturals.com/blogs/electrolytes-hydration/what-energy-drinks-have-electrolytes-exploring-your-hydration-options
8. EVALUATION OF SOME CHEMICAL CONSTITUENTS OF SELECTED ENERGY DRINKS. (s. f.). https://www.projectreserve.com/2017/06/evaluation-of-some-chemical.html

9. How energy drinks without sugar impact your health. (s. f.). GetMTE. https://getmte.com/blogs/learn/the-hidden-ingredients-in-sugar-free-energy-drinks-that-can-affect-your-health
10. Healthy Hydration for Your Kidneys: What to Sip and What to Skip. (s. f.). National Kidney Foundation. https://www.kidney.org/news-stories/healthy-hydration-your-kidneys-what-to-sip-and-what-to-skip
11. Al-Shaar, L., Vercammen, K., Lu, C., Richardson, S., Tamez, M., & Mattei, J. (2017). Health Effects and Public Health Concerns of Energy Drink Consumption in the United States: A Mini-Review. Frontiers In Public Health, 5, 225. https://doi.org/10.3389/fpubh.2017.00225