

# Sports Drinks & Energy Drinks: Comparison on Physico-chemical parameters, Bulk Metals and Nitrate Ions

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## Abstract

Hydration is necessary to maintain peak performance of sportsmen. Water regulates body temperature, lubricates bone joints, and transports nutrients throughout the body. Staying hydrated is particularly important during exercise because body lose water through sweat. The longer and intensely one work out, the more necessary it becomes to get fluid into the body. If don't replenish the fluids, it becomes harder for heart to circulate blood. A decrease in blood and plasma volume can contribute to muscle cramps, dizziness, fatigue, heat stroke, and heat exhaustion. So, sportsmen and athletes generally consume sports drinks and energy drinks to rehydrate body and to maintain refresh body for peak performance. Along with sweat body losses sodium, potassium, calcium etc. important ions also which shows significant biological functions within human body[1]. In this study we tried to find out physico-chemical parameters, bulk metals and nitrate ions within some common sports drinks and energy drinks used by the sportsmen and athletes. All the drinks are strongly acidic, most of them have high TDS, salinity, conductance, sodium ion and nitrate ions. Except Juice monster energy juice (Mango loco), Paper boat jal jeera and Gatorade sports drink (Lemon flavour) all other drinks contain low potassium ion.

**Keywords:** *Physico-chemical parameter, Sodium, Potassium, Calcium, Nitrate.*

## Introduction

Sweat is made mostly of water, but about one percent of sweat is a combination of salt and fat. sweating is primarily a means of thermoregulation, which is achieved by the water-rich secretion of the eccrine glands. Most of the body's sodium is located in blood and in the fluid around cells. Sodium helps the body keep fluids in a normal balance. Sodium plays a key role in normal nerve and muscle function. Calcium is the most plentiful mineral found in the human body. The teeth and bones contain the most calcium. Nerve cells, body tissues, blood, and other body fluids contain the rest of the calcium. Calcium is responsible for Clotting blood, Sending and receiving nerve signals, Squeezing and relaxing muscles, releasing hormones and other chemicals and keeping a normal heartbeat. An adequate intake of potassium is 3400 milligrams per day for healthy adult males and 2,600 milligrams per day for healthy adult females. Potassium deficiency, or hypokalemia, can lead to various health problems like high blood pressure, risk of kidney stones, low calcium levels in the bones etc. Nitrates and nitrites circulate from the digestive

system into the blood, then into saliva, and back into the digestive system[2].They may be useful in keeping human body healthy, as they seem to function as antimicrobials in the digestive system. They can help to kill bacteria, such as *Salmonella*.They can also turn into nitric oxide (NO), an important signaling molecule[3]. Generally carbonated soft drink do not contain caffeine [4][5][6]. Red Bull products contain caffeine[7][8].Though number of research work on carbonated soft drinks are available in literature, still study of sports drinks are less common[9-20].

### Materials and Methods

All the samples subjected for analysis were sealed polymer bottle packs or metal cans and manufactured within last two month of study date. Four are available in metal cans, five in polymer bottles and two in pouch packs (paper boat products). Temperature, pH, Total Dissolved Solid (TDS), conductance and salinity were measured using EUTECH made Multi-parameter PCSTester 35 at the Environmental Chemistry Research Laboratory, Barrackpore RastraguruSurenranath College, Barrackpore, North 24 Parganas, WB. The sodium ion concentrations and potassium ion concentrations were measured at the Environmental Chemistry Research Laboratory, Barrackpore RastraguruSurenranath College, Barrackpore, North 24 Parganas, WB, using Systronics (India) made Flame photometer 128  $\mu$ C. Nitrate and calcium ion concentrations are measured using Systronics (India) made ion meter model number SYS-460 at Environmental Chemistry Research Laboratory, Barrackpore RastraguruSurenranath College, Barrackpore, North 24 Parganas, WB. Calcium ion concentration was measured using ISE 40 electrode. Nitrate ion concentration was measured using ISE 62 electrode. Ion free, redistilled water, prepared at laboratory, were used for all the analysis. All the measurements were carried out between 20°-23°C.

### Results and Discussion

**Table 1:** Name, Make, Batch Number and Energy Value of Sports and energy Drinks Subjected for analysis

NAME	MAKE	BATCH NO.	ENERGY VALUE (kcal/100 ml)
RED BULL SUMMER EDITION (PEACH FLAVOUR)	GMBh& Co OG	1885580	45
JUICE MONSTER ENERGY JUICE (MANGO LOCO)	MONSTER ENERGY INDIA PRIVATE LIMITED	C14PLU11	40
JUICE MONSTER ENERGY ULTRA	MONSTER ENERGY INDIA PRIVATE LIMITED	F23PIF11	03
GATORADE SPORTS DRINK (ORANGE FLAVOUR)	VARUN BEVERAGES LIMITED	6504D14B21	24
GATORADE SPORTS DRINK (BLUE BOLT FLAVOUR)	VARUN BEVERAGES LIMITED	6504D25C21	24

GATORADE SPORTS DRINK (LEMON FLAVOUR)	VARUN BEVERAGES LIMITED	6504D21B21	24
WILD VITAMIN DRINK (LEMONADE FLAVOUR)	RNGalla FAMILY PRIVATE LIMITED	513609:56	25
7 UP NIMBOOZ	VARUN BEVERAGES LIMITED	5255E02C21	45
PAPER BOAT JEERA BUTTER MILK	HECTOR BEVERAGES PRIVATE LIMITED	BB5105	21
PAPER BOAT JAL JEERA	HECTOR BEVERAGES PRIVATE LIMITED	AA9318	49.6
O'CEAN ONE 8 ENERGY DRINK CLASSIC (NATURAL CAFFEINE)	PUSHPAM FOODS AND BEVERAGES	00C27020004	48

**Table 2:**Physico-chemical Parameter Data of Sports and Energy Drinks Subjected for Analysis

NAME	pH	TDS ppm	Salinity ppm	Conductance $\mu$ S
RED BULL SUMMER EDITION(Peach Flavour)	3.05	995	682	1403
JUICE MONSTER ENERGY JUICE(MANGO LOCO)	2.98	754	522	1068
JUICE MONSTER ENERGY ULTRA	3.49	1640	1180	2320
GATORADE SPORTS DRINK(ORANGE FLAVOUR)	3.26	1560	1100	2200
GATORADE SPORTS DRINK(LEMON FLAVOUR)	3.35	1620	1160	2270
GATORADE SPORTS DRINK(BLUE BOLT FLAVOUR)	3.00	1590	1150	2230
WILD VITAMIN DRINK(LEMONADE FLAVOUR)	3.32	570	393	803
7 UP NIMBOOZ	2.95	1650	1190	2330
PAPER BOAT JEERA BUTTER MILK	4.05	8720	7020	12290
PAPER BOAT JAL JEERA	2.85	8670	6990	12120
O'CEAN ONE 8 ENERGY DRINK CLASSIC (NATURAL CAFFEINE)	3.62	1360	965	1937

**Table 3:**Ion Concentration Data of Sports and Energy Drinks (in ppm) Subjected for analysis

NAME	Sodium ion (ppm)	Potassium ion (ppm)	Calcium ion (ppm)	Nitrate ion (ppm)
RED BULL SUMMER EDITION(Peach Flavour)	645.6	214.50	1935	75

JUICE MONSTER ENERGY JUICE(MANGO LOCO)	364.40	444.20	8133	37
JUICE MONSTER ENERGY ULTRA	668.10	17.70	2664	50
GATORADE SPORTS DRINK(ORANGE FLAVOUR)	504.30	163.20	1057	51
GATORADE SPORTS DRINK(LEMON FLAVOUR)	963.10	314.20	26	46
GATORADE SPORTS DRINK(BLUE BOLT FLAVOUR)	754.5	274.8	68	444
WILD VITAMIN DRINK(LEMONADE FLAVOUR)	33.37	40.93	314	70
7 UP NIMBOOZ	1110.50	156.30	3625	68
PAPER BOAT JEERA BUTTER MILK	974.80	244.40	9060	27
PAPER BOAT JAL JEERA	1331.70	386.70	666	59
O'CEAN ONE 8 ENERGY DRINK CLASSIC (NATURAL CAFFEINE)	1067.25	4.50	419	68

Red bull summer edition peach flavor contains 75 mg/250 ml caffeine, O'cean one 8 energy drink classic natural contains 30 mg/100 ml caffeine Whereas Juice monster products contains high caffeine content. Juice monster energy juice mango loco contains 100 mg/350 ml caffeine and Juice monster energy ultra contains 105mg/350ml caffeine. Paper boat jal jeera provide maximum energy (49.6 kcal/100 ml) and Juice monster energy ultra provides minimum energy (3 kcal/100 ml). According to pH the drinks can be arranged as Paper boat jal jeera < 7 Up nimbooz < Juice monster energy juice (Mango loco) < Gatorade sports drink (Blue bolt flavour) < Red bull summer edition (Peach flavor) < Gatorade sports drink (Orange flavour) < Wild vitamin drink (Lemonade flavour) < Gatorade sports drink (Lemon flavour) < Juice monster energy ultra < O'cean one 8 energy drink classic (Natural caffeine) < Paper boat jeera butter milk. With respect to total dissolved solid (TDS) the drinks may be arranged as Wild vitamin drink (Lemonade flavour) < Juice monster energy juice (Mango loco) < Red bull summer edition (Peach flavor) < O'cean one 8 energy drink classic (Natural caffeine) < Gatorade sports drink (Orange flavour) < Gatorade sports drink (Blue bolt flavour) < Gatorade sports drink (Lemon flavour) < Juice monster energy ultra < 7 Up nimbooz < Paper boat jal jeera < Paper boat jeera butter milk. The order of salinity can be described as Wild vitamin drink (Lemonade flavour) < Juice monster energy juice (Mango loco) < Red bull summer edition (Peach flavor) < O'cean one 8 energy drink classic (Natural caffeine) < Gatorade sports drink (Orange flavour) < Gatorade sports drink (Blue bolt flavour) < Gatorade sports drink (Lemon flavour) < Juice monster energy ultra < 7 Up nimbooz < Paper boat jal jeera < Paper boat jeera butter milk. The conductance values can be arranged as Wild vitamin drink (Lemonade flavour) < Juice monster energy juice (Mango loco) < Red bull summer edition (Peach flavor) < O'cean one 8 energy drink classic (Natural caffeine) < Gatorade sports drink (Orange flavour) < Gatorade sports drink (Blue bolt flavour) < Gatorade sports drink (Lemon flavour) < Juice monster energy ultra < 7 Up nimbooz < Paper boat jal jeera < Paper boat jeera butter milk.

With respect to sodium ion concentration these may be arranged as Wild vitamin drink (Lemonade flavour) < Juice monster energy juice (Mango loco) < Gatorade sports drink (Orange flavour) < Red bull summer edition (Peach flavor) < Juice monster energy ultra < Gatorade sports drink (Blue bolt flavour) < Gatorade sports drink (Lemon flavour) < Paper boat jeera butter milk < O'cean one 8 energy drink classic (Natural caffeine) < 7 Up nimbooz <

Paper boat jal jeera. The order with respect to potassium ion concentration is O'cean one 8 energy drink classic (Natural caffeine) < Juice monster energy ultra < Wild vitamin drink (Lemonade flavour) < Gatorade sports drink (Orange flavour) < 7 Up nimbooz < Red bull summer edition (Peach flavor) < Paper boat jeera butter milk < Gatorade sports drink (Blue bolt flavour) < Gatorade sports drink (Lemon flavour) < Paper boat jal jeera < Juice monster energy juice (Mango loco).

The order with respect to potassium ion concentration is < O'cean one 8 energy drink classic (Natural caffeine) < Juice monster energy ultra < Wild vitamin drink (Lemonade flavour) < Gatorade sports drink (Orange flavour) < 7 Up nimbooz < Red bull summer edition (Peach flavor) < Paper boat jeera butter milk < Gatorade sports drink (Blue bolt flavour) < Gatorade sports drink (Lemon flavour) < Juice monster energy juice (Mango loco). Ascending order of calcium ion concentration within these drinks are Gatorade sports drink (Lemon flavour) < Gatorade sports drink (Blue bolt flavour) < Wild vitamin drink (Lemonade flavour) < O'cean one 8 energy drink classic (Natural caffeine) < Paper boat jal jeera < Gatorade sports drink (Orange flavour) < Red bull summer edition (Peach flavor) < Juice monster energy ultra < 7 Up nimbooz < Juice monster energy juice (Mango loco) < Paper boat jeera butter milk. The studied drinks may be arranged with reference to nitrate ion concentration as Paper boat jeera butter milk < Juice monster energy juice (Mango loco) < Gatorade sports drink (Lemon flavour) < Juice monster energy ultra < Gatorade sports drink (Orange flavour) < Paper boat jal jeera < 7 Up nimbooz = O'cean one 8 energy drink classic (Natural caffeine) < Wild vitamin drink (Lemonade flavour) < Red bull summer edition (Peach flavor) < Gatorade sports drink (Blue bolt flavour).

### Conclusion

Caffeine works by stimulating the central nervous system (CNS), heart, muscles, and the centers that control blood pressure. Caffeine can raise blood pressure, but might not have this effect in people who use it all the time. Caffeine can also act like a "water pill" that increases urine flow. Red bull summer edition peach flavor, O'cean one 8 energy drink classic natural and Juice monster products act as stimulator for our nervous system and other organs. All the drinks are highly acidic and have pH value below 4.06. Paper boat jal jeera is the most acidic (pH 2.85) and Paper boat jeera butter milk is least among these (pH 4.05). TDS, salinity and conductance values showed similar trends for the drinks studied. Wild vitamin drink (Lemonade flavour) has the lowest TDS (570 ppm), Salinity (393 ppm) and conductance (803  $\mu$ S), whereas Paper boat jeera butter milk shows highest TDS (8720 ppm), Salinity (7020 ppm) and conductance (12290  $\mu$ S). Gatorade products have almost similar TDS, salinity and Conductance. High salinity and conductance reveal the presence of larger number of ions.

In addition to water, body loses electrolytes when it sweats. Chloride, potassium, and sodium are major electrolytes, which are minerals in blood, urine, and bodily fluids that contain an electric charge. Cells use electrolytes to carry electrical impulses that help cells communicate with each other and give the ability to taste, see, smell, touch, and hear. Maximum sweat rates of an adult can be up to 2–4 liters per hour or 10–14 liters per day. Sodium concentration in sweat is normally 30–65 mmol/l, some measured concentrations are: sodium (0.9 gram/liter), potassium (0.2 g/L), calcium (0.015 g/L), and magnesium (0.0013 g/L). The body is made of

approximately 60% water. 40% of this water is found inside the body cells in a substance called intracellular fluid (ICF). The remainder is found outside the cells in areas such as blood, spinal fluid and between cells. This fluid is called extracellular fluid (ECF). Interestingly, the amount of water in the intracellular fluid and extracellular fluid is affected by their concentration of electrolytes, especially potassium and sodium. Potassium is the main electrolyte in the intracellular fluid, and it determines the amount of water inside the cells. Conversely, sodium is the main electrolyte in the extracellular fluid, and it determines the amount of water outside the cells. Having high sodium levels can increase the risk of high blood pressure. In healthy people, potassium lowers this risk by helping the body remove sodium. It also helps manage blood pressure by relaxing the walls of the blood vessels. The body obtains sodium through food and drink and loses it primarily in sweat and urine. Healthy kidneys maintain a consistent level of sodium in the body by adjusting the amount excreted in the urine. When sodium consumption and loss are not in balance, the total amount of sodium in the body is affected. Table 3 clearly shows that, only Paper boat jeera butter milk and Juice monster energy juice (Mango loco) have sufficient potassium ion concentration. However, Ocean One 8 energy drink classic (Natural caffeine) and Wild vitamin drink (Lemonade flavour) are good for kidney patients with respect to potassium ions. Except Juice monster energy juice (Mango loco) and Paper boat jeera butter milk all other drinks contain high nitrate ions with reference to WHO prescribed limit.

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