

DRINKING WATER STABILIZATION

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ABSTRACT

The goal of this project is to design an optimum mineral composition that takes into account the nutritional requirements of children, adults, and seniors. The minerals will be added into reverse osmosis (RO) bottled water because the minerals have been stripped from the water lowering the mineral content to a trace amount, which can have detrimental health effects. Therefore, it is necessary to use salt chemicals in order to bring mineral stability to the RO bottled water.

BACKGROUND

The main focus of this project is to improve the health quality of bottled water that has been treated by RO by adding an optimum mineral additive. During RO, water is passed through a pressurized membrane, which yields a pure water that is devoid of nearly all minerals⁶. When RO water is consumed, calcium as well as many other nutrients are stripped from the skeletal system causing health issues such as osteoporosis, cardiovascular disease, and kidney stones².

Under the Food and Drug Administration (FDA), there are some minerals that are not regulated nor are bottled water companies that use RO required to reinstate minerals back into water bottles. The team has chosen to add calcium, iron, magnesium, iodine, potassium, zinc, and sodium to the mineral composition because, after some research, these were the minerals that adults, the elderly, and children all require in their daily diets. Table 1 shows the current regulatory maximum concentrations for the chosen minerals.

Table 1. Regulatory Maximum Concentrations for the Minerals.

Mineral	Regulatory Max Concentration (mg/L)
Calcium	Not Regulated
Iron	0.3
Magnesium	Not Regulated
Iodine	Not Regulated
Potassium	Not Regulated
Zinc	5
Sodium	Not Regulated

Three popular RO bottled water brands will undergo lab work to provide the team with estimates of existing mineral concentrations in RO water.

The World Health Organization (WHO) mineral concentration recommendations and the recommended dietary allowances (RDA) from the U.S. Department of Health & Human Services were used to pinpoint the possible testing concentrations in the composition. Since the RDA's for the three different age groups vary, the average RDA was calculated and can be seen in Table 2.

Table 2. RDA average values.

Mineral	RDA Average (mg/day)
Calcium	1000 ⁴
Iron	11 ⁴
Magnesium	270 ⁴
Iodine	0.12 ⁴
Potassium	3450 ¹
Zinc	18 ⁴
Sodium	>2300 ⁷

TESTS

Based on the FDA regulatory maximum concentrations for bottled water, the team performed the following tests for quality and quantity purposes³:

- Anion and Cation Concentrations
- Total Dissolved Solids (TDS)
- Conductivity
- Turbidity
- Color
- Odor
- Alkalinity
- Acidity
- Hardness
- pH



The anion and cation testing helped to identify the current mineral content in popular RO bottled water brands. The TDS test assisted to identify the content of solids present in the water. The higher the TDS, the higher the conductivity and turbidity values. Therefore, the more turbid the water, the more suspended and colloidal matter is present, which correlates to a higher ability to carry an electrical current. Alkalinity, acidity, hardness, and pH testing was needed to assure the water will not be too acidic, basic, or hard. The team wants the pH of the optimum mineral composition to fall between the Environmental Protection Agency (EPA) recommended pH range of 6.5 and 8.5 for drinking water⁵. Finally, the color and odor testing was required for aesthetic evaluation of the mineral composition.

RESULTS

The results for the first three compositions can be seen in Table 3.

Table 3. Results for the First Three Mineral Compositions.

Test	Composition 1	Composition 2	Composition 3
pH	8.90	8.75	8.60
Total Dissolved Solids (mg/L)	290.67	212.00	148.33
Turbidity (NTU)	23.22	5.73	4.31
Conductivity (mA/V*m)	54.90	39.33	28.07
Alkalinity (mg CaCO ₃ /L)	176.00	134.00	102.67
Acidity (mg CaCO ₃ /L)	N/A	N/A	N/A
Hardness (mg CaCO ₃ /L)	181.98	132.30	48.80
Hardness Classification	Very Hard	Hard	Slightly Hard
Color (PtCo)	10.00	7.33	5.33
Odor	Slight Smell	No Smell	No Smell

Since the first three compositions were above the pH range for drinking water, two additional compositions were designed and tested. The test results of the next two mineral compositions can be seen in Table 4.

Table 4. Results for the Two Additional Mineral Compositions.

Test	Composition 4	Composition 5
pH	7.60	7.50
Total Dissolved Solids (mg/L)	56.67	55.67
Turbidity (NTU)	0.97	0.43
Alkalinity (mg CaCO ₃ /L)	26.33	25.50
Acidity (mg CaCO ₃ /L)	-23.33	-21.50
Conductivity (mA/V*m)	10.77	10.63
Hardness (mg CaCO ₃ /L)	48.80	48.80
Hardness Classification	Slightly Hard	Slightly Hard
Color (PtCo)	4.00	3.33
Odor	No Smell	No Smell

SUMMARY

The mineral composition that was chosen to be the optimum mineral composition was composition 5. The composition was chosen because it had the best results of all of the compositions. The percent daily values for composition 5 can be seen in Table 5. This mineral composition satisfies all regulations and has daily percent values from 0.1% to 17%. These minerals are essential in the diets of children, adults, and seniors and will increase the mineral content in reverse osmosis bottled water.

Table 5. % Daily Value of RO Bottled Water vs Composition 5.

Mineral	RDA Average (mg/day)	Popular RO Bottled Water (mg/L)	% Daily Value	Composition 5 (mg/L)	% Daily Value
Calcium	1000 ⁴	0	0%	8	2%
Iron	11 ⁴	0	0%	0.005	0.1%
Magnesium	270 ⁴	0	0%	10	11%
Iodine	0.12 ⁴	0	0%	0.001	3%
Potassium	3450 ¹	0	0%	7	1%
Zinc	18 ⁴	0	0%	1	17%
Sodium	>2300 ⁷	1	0%	12	2%

Furthermore, the theoretical prices of the 1-mL capsules for the optimum mineral composition in three different bottle sizes can be seen in Table 6.

Table 6. Packaging Bottle Size, Quantity, and Price.

Packaging Bottle Size	Capsules /Bottle Size	Price
4 oz	28	\$ 2.99
8 oz	60	\$ 5.49
16 oz	140	\$11.99

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Sincerely,

