Titrimetric Estimation of Calcium from Different Milk Samples

IB Chemistry HL

Research Question:

What type of milk contains the most calcium?

Introduction:

Personal Engagement:

The idea for this investigation came from my experience as a Starbucks employee. We use many different kinds of non-dairy milks in addition to our cow milk in our lattes based on customer preference, but we do not provide milk from other animals. Thus I want to experiment with the possibility of selling other milk alternatives that are more nutritious.

Relevance:

This topic is relevant because the human body contains about 1200 grams of calcium,[1] but cannot produce calcium itself. This means it is essential that we are eating enough calcium for our overall bone health. Therefore, with this information, Starbucks should be selling the most calcium-potent milk they can to improve the health of their customers.

Environmental and Ethical Concerns

There are no environmental or ethical concerns.

Background

Milk is made of many different components, such as carbohydrates, protein, fats, enzyme, vitamins, water, organic acids, and minerals like calcium. The high mineral content specifically in milk makes it an essential source to the human body, especially since calcium is

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[1] Traverso, Matt. "Calcium in the Body." General Chemistry Lab Tutorials. Washington University in St. Louis, August 8, 2004. http://www.chemistry.wustl.edu/~edudev/LabTutorials/CourseTutorials/Tutorials/Vitamins/calcium.htm.

one of the most important minerals in the human body. It is important for intracellular metabolism, bone growth, blood clotting, nerve conduction, muscle contraction, cardiac function, fertilization, heart rate, nerve conduction, stability of blood pressure, strength of bones and teeth.[2] About 1% of calcium in the body goes into the bodily fluids in the form of a free cation Ca2+, bound to a protein, or complexed with other ions. The cation is considered the most important of the three because it impacts physiological functions such as blood clotting, transmission of nerve impulses, muscle contraction, stability of cell membranes and cell metabolism.[3] Goat and Buffalo milk is thus important to consider over cow milk because they both provide a great amount of calcium.

Methodology:

Summary of Experiment:

1. 0.01M EDTA - 3.7224 gm of EDTA was weighed, dissolved in distilled water and volume was raised up to 1 Liter.
2. Ammonia – Ammonium Chloride (NH4Cl) solution as buffer (pH=10) :- 17.5 gm of Ammonium Chloride was mixed with 142 ml of Concentrated Ammonia (Sp. Gravity 0.88-0.90) and made up to 250 ml with distilled water. pH was adjusted by pH meter (EQUIP-TRONICS, Mumbai, India) up to 10.

Different milk samples were obtained from animals viz. Desi cow, Jersey cow, Goat, and Buffalo. Commercially available packaged milk samples were obtained from Sangamner Taluka Sahakari Dudh Utpadak and Prakriya Sangh Ltd. Rajhans Milk (referred to as Rajhans milk

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[2] Pingle, Shrihari & Pawar, Varsha & Bhagde, Rupendra. (2016). TITRIMETRIC ESTIMATION OF CALCIUM FROM DIFFERENT MILK SAMPLES FROM SANGAMNER TALUKA, MAHARASHTRA. Trends in Life Sciences. 5. 1-3.

[3] Traverso, Matt. "Calcium in the Body." General Chemistry Lab Tutorials. Washington University in St. Louis, August 8, 2004. http://www.chemistry.wustl.edu/~edudev/LabTutorials/CourseTutorials/Tutorials/Vitamins/calcium.htm.

henceforth) and S .R. Thorat Milk products Pvt. Ltd. (referred to as S.R. Thorat milk henceforth). The fresh milk samples were collected in properly washed and cleaned bottles. All milk samples were brought to laboratory for estimating amount of Calcium. Estimation of Calcium of various milk samples was carried out by EDTA titration method (Camp and Seely, n.d.).[4]

Amount of calcium was determined as follows:

$$\text{Molarity of Calcium} = \frac{\text{Molarity of EDTA} \times \text{MBR}}{\text{Volume of Milk}}$$

$$\text{Amount of Calcium} = \frac{\text{Molecular Weight of Calcium} \times \text{Molarity of Calcium}}{1}$$

Data:

The table below depicts the mean calcium content of the milk in mg/lit, the standard deviation (SD), and the standard error (SE). Twenty samples of various milks were tested without subjecting the milk to boiling.[5] The highest calcium content was found to be in Goat milk at 2067.0mg/lit.± 100.78, with Buffalo milk following closely behind at 1993.3mg/lit.±107.46. Next, the Desi cow had a mean calcium content of 1594.0mg/lit±99.61 and the Jersey cow has 1483.4mg/lit.±97.14. The two commercial milks had the lowest calcium concentration of all six milks, with S.R Thorat's at 1362.5mg/lit±65.47 and Rajhans milk at 1354.7mg/lit.±44.84.

Table 1 Calcium Content from Different Milk Samples

Sample Source	Mean Calcium Content	SD	SE
Desi cow	1594.0	99.61	22.27
Jersey cow	1483.4	97.14	21.72
Buffalo	1993.3	107.46	24.03
Goat	2067.0	100.78	22.53
Rajhans milk	1354.7	44.84	10.02
S.R.Thorat milk	1362.5	65.47	14.63

The graph below presents the contents of the table visually. The significant comparison between the mean calcium content in goat's milk and the mean calcium content Rajhan's commercialized milk is more accentuated.

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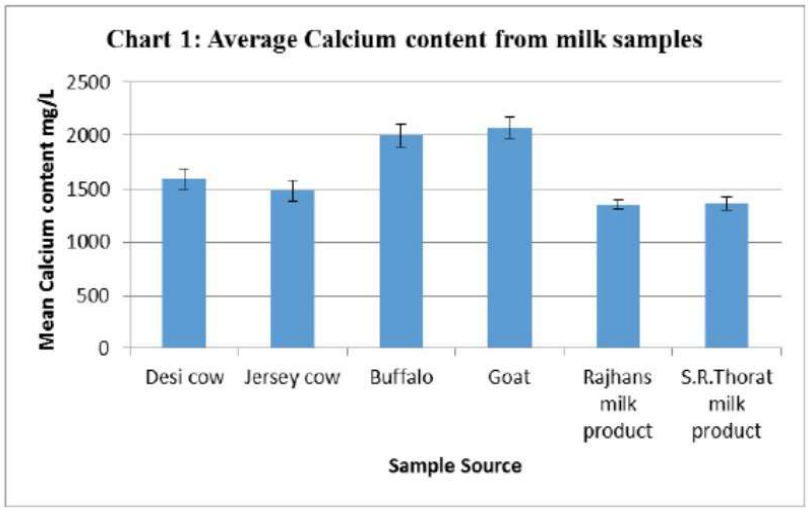
[4] Pingle, Shrihari & Pawar, Varsha & Bhagde, Rupendra. (2016). TITRIMETRIC ESTIMATION OF CALCIUM FROM DIFFERENT MILK SAMPLES FROM SANGAMNER TALUKA, MAHARASHTRA. Trends in Life Sciences. 5. 1-3.

[5] ditto



Conclusion:

Commercial milks produced the least amount of mean calcium content. Therefore, I believe that Starbucks should be considering the use of other milks in their latte such, as goat milk. This will be better for customer health and provide a wider selection of choice for customer preference. This will also allow for an increased concentration of the cation Ca2+ in bodily fluids and help to meet the necessary amount of calcium need for every day function.

Bibliography

Pingle, Shrihari & Pawar, Varsha & Bhagde, Rupendra. (2016). TITRIMETRIC ESTIMATION OF CALCIUM FROM DIFFERENT MILK SAMPLES FROM SANGAMNER TALUKA, MAHARASHTRA. Trends in Life Sciences. 5. 1-3.

Traverso, Matt. "Calcium in the Body." General Chemistry Lab Tutorials. Washington University in St. Louis, August 8, 2004. http://www.chemistry.wustl.edu/~edudev/LabTutorials/CourseTutorials/Tutorials/Vitamins/calcium.htm.