Determination of Sodium, Potassium, and Calcium Content in Diverse Mango Fruit Varieties and Mango Flavoured Beverages from Nuzvid, EluruDistrict, AP through Flame Photometry

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Article History: Received: 06.04.2023 Revised: 01.05.2023 Accepted: 09.05.2023

Abstract:

The estimation of sodium, potassium, and calcium concentrations in various mango samples and mango fruit beverages was carried out using flame photometry. The regression equations derived from the calibration curves were employed to estimate the concentrations of sodium, potassium, and calcium in the mango samples and beverages. The regression equations provided a reliable method for estimating the concentrations of sodium, potassium, and calcium in parts per million (ppm) for different mango samples and mango fruit beverages. The use of flame photometry allowed for accurate and efficient analysis, enabling a better understanding of the nutritional composition of mangoes and their derived products. Such information can be valuable for quality control purposes and for assessing the nutritional value of mango-based food and beverage products.

Keywords- Mango, Sodium, potassium, calcium and flame photometry

DOI:10.48047/ecb/2023.12.5.492

Introduction:

The mango (Mangiferaindica L.), a member of the Anacardiaceae family, holds significant importance as a fruit crop in India and subtropical regions worldwide. Recognized for its delectable taste, high palatability, sweet fragrance, attractive color, and nutritional value, mangoes are cherished for their contribution to vitamin A, B, C, and β-carotene levels, as well as their content of nutritive minerals, digestible sugars, and trace elements. The captivating taste, flavor, and aroma of mangoes are widely appreciated by people of all ages. Additionally, the mango kernel contains carbohydrates, carotene, riboflavin, thiamine, protein, fat, and calcium, which also possess medicinal properties. In India, mango cultivation spans across 1.60 million hectares, yielding a staggering production of 11.40 million tons, making it the largest mango producer globally, accounting for over 50 percent of the world's output[1].Fruit juices have become increasingly significant in the modern diet across various communities. These nutritious beverages can play a vital role in maintaining a healthy diet as they provide both great taste and a diverse range of nutrients naturally found in fruits. Juices are available either in their natural concentrations or in processed forms. The process of juice preparation involves mechanically squeezing fresh fruits or extracting the juice using water. These fat-free beverages are packed with nutrients, making them dense in vitamins, minerals, and naturally occurring phytonutrients that contribute to overall well-being and good health[2].Mango juice is known for its richness in vitamin C, making it an excellent source of bio-available antioxidant phytochemicals [3]. It has been found to have a significant positive impact on blood lipid profiles in individuals with hypercholesterolemia[4], as shown in studies conducted by Kurowska et al. (2000). Furthermore, fruit juices, including mango juice, are known to promote detoxification within the human body [5].The mango fruit offers various benefits, including its positive effects on nephritis treatment and other kidney-related issues, as highlighted by Islam [6]. It serves as an excellent source of energy and is rich in essential nutrients such as vitamins A, vitamin C, iron, and phosphorus, etc..[7].

Additionally, postharvest handling practices have an influence on the total content of carotenoids, phenolic compounds, vitamin C, antioxidant capacity, and organoleptic properties of mangoes [8].

The Banaganapalli mango, also referred to as "The King of Mangoes," derives its name from the town of Banganapalli. This particular mango variety showcases a flawless, obliquely oval shape, adorned with a thin, golden yellow skin that remains unblemished. Weighing an average of 350-400 grams, these mangoes boast an ample size. The pulp, free from fibrous strands, retains its firmness and showcases a vibrant yellow hue, complemented by its delectable sweetness.[9-10].

Chinnarasalu or Chinnarasamulu, an Indian mango variety originating in Nuzvid, Andhra Pradesh, India, is renowned for its exceptional juiciness. This luscious mango variant thrives in the southern regions of Andhra Pradesh and Telangana. Moreover, there exists a larger version of Chinnarasalu called Cherukurasalu, which possesses an inherent sweetness akin to sugarcane. Its name is derived from the Telugu term "cheruku," which translates to sugarcane. Cherukurasalu stands as a testament to the magnificence of this delectable fruit.[11].CherukuRasalu, characterized by its ample size and abundant sweet juice content, belongs to the larger variety of mangoes. These mangoes, renowned for their generous proportions, are predominantly cultivated in the East Godavari districts. While they maintain a medium size, their juice exhibits an exceptional sweetness. This particular variety can be found thriving across the state of Andhra Pradesh. Another well-known type is the Nuzividu variety, which features smaller mangoes packed with incredibly sweet juice. These mangoes have gained popularity in the Krishna and Guntur districts of Andhra Pradesh.[12]. PeddaRasalu, the immensely popular juicy mango variety from Andhra Pradesh, is renowned for its aromatic and lemon-yellow appearance. Its pulp is delightfully fibrous and succulent, making it a perfect choice for consumption. This exceptional breed of mangoes is harvested at the precise moment of ripeness, allowing for natural ripening. Additionally, PeddaRasalu mangoes boast a remarkable mineral content, including iron, folate, and magnesium. In South India, they hold a special place as one of the most sought-after mango varieties. When fully ripe, a PeddaRasalu mango surpasses other mangoes, even challenging the famed Alphonso variety, in terms of taste and the amount of juice per mango. In certain regions like Bengaluru, Raspuri mangoes are highly coveted, with many individuals specifically requesting this variety above all others [13].

Mango beverages

Mango juice, nectar, and squash are three significant beverages produced on a commercial scale. Due to the high viscosity of mango pulp, mango juice is prepared by diluting it with nearly equal amounts of water and adjusting the overall soluble solids and acidity to achieve the desired taste. Typically, the juice contains 12 to 15% total soluble solids (TSS) and 0.4 to 0.5% acidity. Mango nectar, on the other hand, consists of 20% pulp blended with sugar and acidity appropriately adjusted to attain 15°Brix (B) sweetness and 0.3% acidity, typically citric acid. These beverages are packaged in cans. Mango squash, which contains 25% juice, 45% TSS, and 1.2 to 1.5% acidity, is preserved using sulfur dioxide (350 ppm) or sodium benzoate (1000 ppm) and packaged in glass bottles Mango nectar is prepared using dehydrated ripe mango slices and sugar in a 4:3 ratio, resulting in a final product with 20% pulp, 15°Brix sweetness, and 0.23% acidity, taking into consideration factors such as flavor, color, and texture.[14].The market has witnessed a surge in the availability of numerous new brands of fruit juice-based beverages, offered in glass, plastic containers, and brick packs. Despite the existence of food laws governing the production of high-quality food products, many manufacturers fail to adhere strictly to these regulations. The adulteration of food can pose significant dangers to the well-being of society, contributing to various diseases such as paralysis, cancer, mental retardation, and hypertension. Therefore, it is crucial to take necessary measures to combat food adulteration and ensure food safety.

For beverages to meet quality standards, they must exhibit stability, homogeneity, and the absence of particle aggregation. However, there are three physical phenomena that can lead to the instability of a suspension: sedimentation, aggregation, and coalescence. Sedimentation occurs when there is a difference in density between the dispersed phase and the continuous phase, resulting in the separation of two phases with distinct concentrations and viscosities. The settling of suspended particles varies depending on their characteristics and concentration. Discrete particles refer to those whose properties, such as shape, size, and density, remain constant. During free sedimentation, where no interactions occur between particles, hydraulic forces hold the particles in place, and their descent can be described by Stokes' law [15].The volatile components present in fruit juices play a vital role in influencing the sensory quality of the juices, particularly after undergoing heat processing and storage. Among different fruit products, mango juice has garnered significant attention in research investigations [16].

Materials and Method:

PREPARATION OF STANDARD SOLUTIONS

1000 ppm standard NaCl solution:

To prepare a standard solution of 1000 ml NaCl, an accurate weight of 2.5416 grams of sodium chloride was measured using an analytical balance. The salt was then carefully transferred quantitatively into a 1000 ml volumetric flask using a funnel. To ensure complete transfer, a few squirts of distilled water were used from a wash bottle on the weighing boat and the sides of the flask. Approximately 100 ml of distilled water was added to the flask and swirled multiple times until all the NaCl dissolved. The solution was then diluted with distilled water to the mark on the flask, resulting in a stock solution of NaCl. From this stock solution, a series of 1, 10, 20, 30, 40, 50, and 100 ppm NaCl solutions can be prepared.

1000ppm Standard KCl Solution:

Using an analytical balance, 1.9070 grams of potassium chloride (KCl) was accurately weighed. The salt was then quantitatively transferred into a 1000 mL volumetric flask with the help of a funnel. To ensure complete transfer, a few squirts of distilled water were used from a wash bottle to rinse the weighing boat and the sides of the flask, ensuring all the KCl made its way into the flask. Subsequently, approximately 100 ml of deionized water was added to the flask and swirled several times until all the KCl was dissolved. The solution was then diluted with distilled water up to the mark on the flask, resulting in a stock solution of KCl. From this stock solution, a series of standard solutions with concentrations of 1, 10, 20, 30, 40, 50, and 100 ppm of KCl can be prepared. These standard solutions allow for the measurement of the intensity of the absorbed light, providing valuable information for further analysis and experimentation.

1000ppm standard $CaCO_3$ solution:

An accurate measurement of 2.497 grams of calcium carbonate was obtained using an analytical balance. The calcium carbonate was dissolved in 300 milliliters of distilled water, and 10 milliliters of HCl were added. The resulting mixture was then transferred quantitatively into a 1000-milliliter volumetric flask using a funnel.To ensure that all of the calcium carbonate was properly transferred, a few squirts of distilled water were used from a wash bottle to rinse the weighing boat and the sides of the flask. Approximately 300 milliliters of deionized water were added to the flask, which was then swirled several times to

dissolve all of the CaCO3. The solution was then diluted with distilled water and brought up to the mark on the flask, resulting in a stock solution of CaCO3 with a concentration of 1000 parts per million (ppm).From this stock solution, a series of CaCO3 solutions with concentrations of 10, 20, 40, 60, 80, and 100 ppm can be prepared.

RESULTS AND DISCUSSION

To determine the sodium, potassium, and calcium content in different mango fruits and mango beverages, the line of regression from the standard graph of Na, K, and Ca was utilized. The regression equations derived from the sodium, potassium, and calcium calibration curves were as follows:

For sodium: Y = 1.05X + 2.53 (R2 = 0.998)

For potassium: Y = 1.03X + 3.318 (R2 = 0.997)

For calcium: Y = 2.937X + 0.4199 (R2 = 0.999)

These equations provide a means to estimate the concentrations of sodium, potassium, and calcium in parts per million (ppm) for the mango samples and beverages.

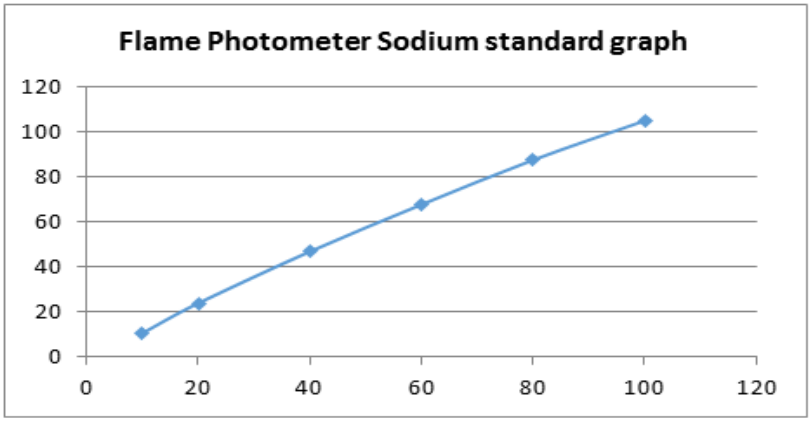


Fig 2: Sodium standard graph

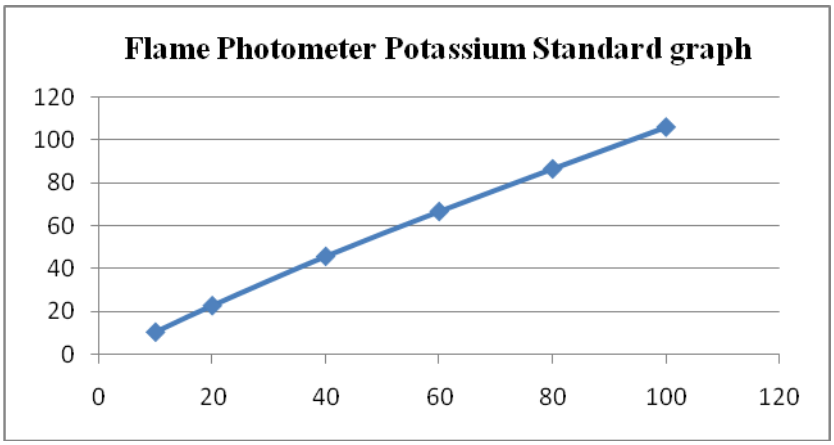


Fig 3: Potassium standard graph

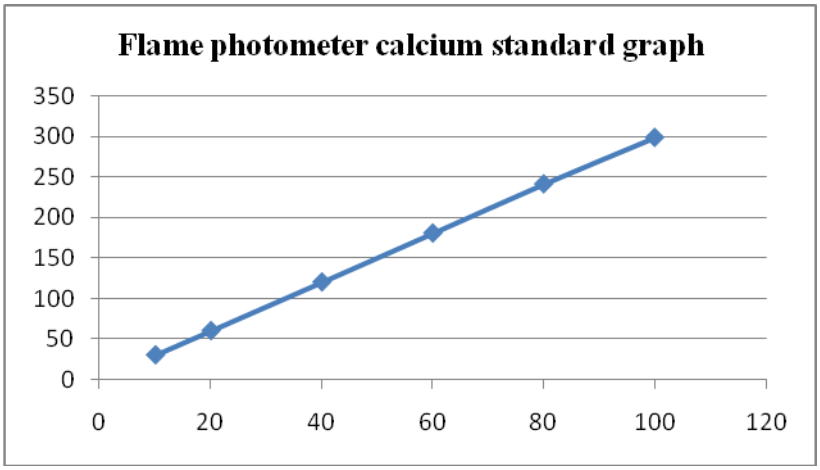
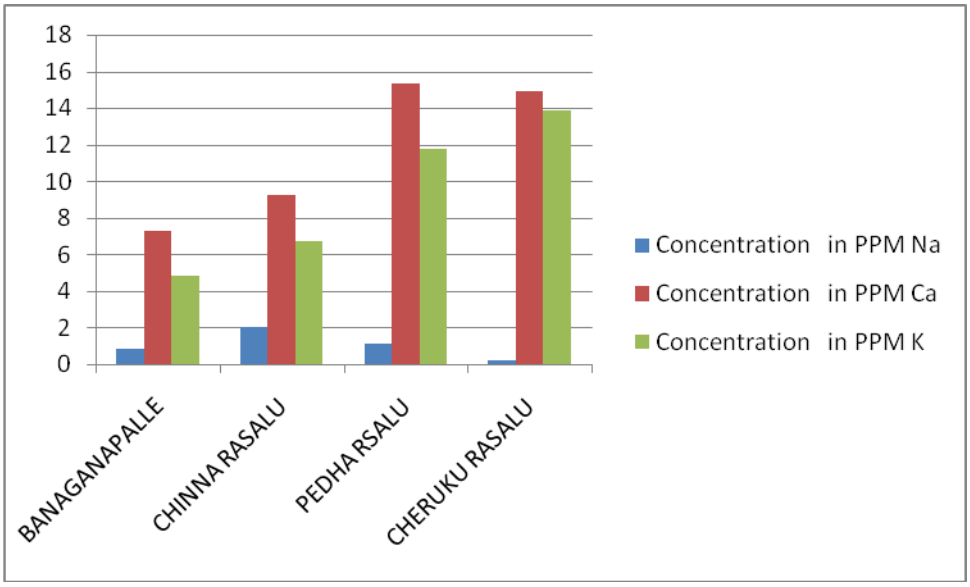


Fig 4: Calcium standard graph

The potassium, sodium, and calcium contents of mango fruit samples and mango beverages were analyzed using flame photometry. Table 1 presents the mean values obtained from triplicate analyses.

Table 1: Concentration of Na, Ca and K in the Mango Fruit Samples

S.NO	**SAMPLE**	**Concentration in PPM**		
		Na	**Ca**	**K**
1	BANAGANAPALLE	0.8193	7.2997	4.8120
2	CHINNA RASALU	2.00963	9.2597	6.7520
3	PEDHA RSALU	1.1388	15.3197	11.7320
4	CHERUKU RASALU	0.2288	14.8897	13.8820



Sodium (Na):

Among the mango fruit samples analysed, the highest concentration of sodium was found in the "CHINNA RASALU" variety, with a mean value of 2.0096 ppm. The lowest sodium concentration was observed in the "CHERUKU RASALU" variety, with a mean value of 0.2288 ppm. The "BANAGANAPALLE" and "PEDHA RASALU" varieties exhibited intermediate levels of sodium content.

Calcium (Ca):

The "PEDHA RASALU" variety demonstrated the highest calcium concentration among the mango fruit samples, with a mean value of 15.3197 ppm. The "CHERUKU RASALU" variety displayed the second-highest calcium content, with a mean value of 14.8897 ppm. The "BANAGANAPALLE" and "CHINNA RASALU" varieties showed lower calcium concentrations compared to the previous two varieties but were still within the analysed range.

Potassium (K):

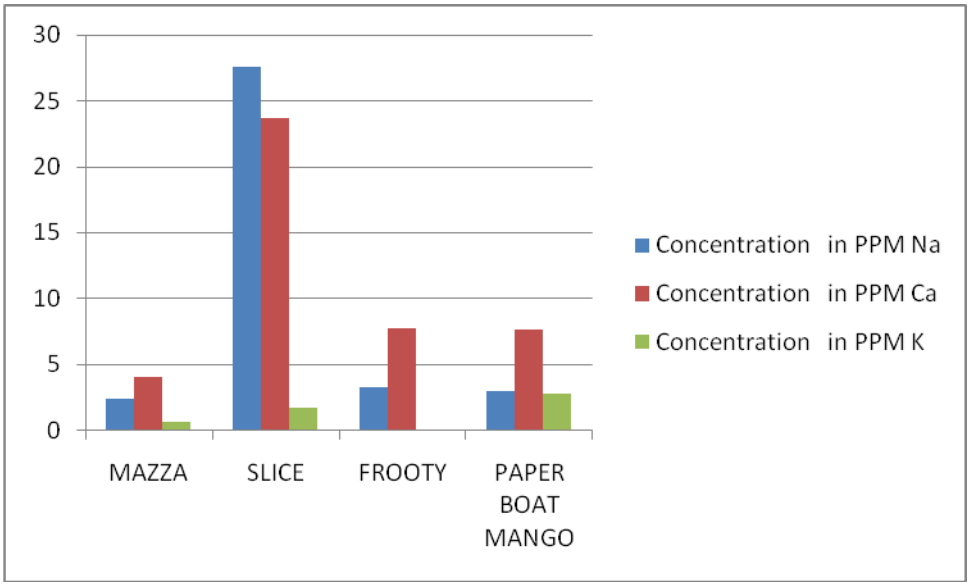
The "CHERUKU RASALU" variety exhibited the highest potassium concentration among the mango fruit samples, with a mean value of 13.8820 ppm. The "PEDHA RASALU" variety showed the second-highest potassium content, with a mean value of 11.7320 ppm. The "BANAGANAPALLE" and "CHINNA RASALU" varieties displayed lower potassium concentrations but were still within the analysed range.

These results indicate that there are variations in the concentrations of sodium, calcium, and potassium among the different mango fruit samples. It is important to note that the concentrations reported here represent the mean values obtained from triplicate analyses, which helps to reduce the impact of experimental variability.

The concentrations of sodium (Na), calcium (Ca), and potassium (K) were analysed in different beverage samples using flame photometry. The mean values obtained from triplicate analysis are presented in Table 2.

Table 2: Concentration of Na, Ca and K in the Beverages

S.NO	SAMPLE	Concentration in PPM		
		Na	Ca	K
1	MAZZA	2.3188	3.9897	0.5920
2	SLICE	27.5688	23.6979	1.6920
3	FROOTY	3.2188	7.7297	.0.80204
4	PAPER BOAT MANGO	2.9488	7.5597	2.7720



Sodium (Na):

The highest concentration of sodium was found in the "SLICE" beverage, with a mean value of 27.5688 ppm. The lowest sodium concentration was observed in the"MAZZA" beverage, with a mean value of 2.3188 ppm. The "FROOTYand"PAPER BOAT MANGO" beverages exhibited intermediate levels of sodium content.

Calcium (Ca):

Among the beverage samples analysed, the "SLICE" beverage demonstrated the highest calcium concentration, with a mean value of 23.6979 ppm. The "FROOTY" beverage displayed the second-highest calcium content, with a mean value of 7.7297 ppm. The "MAZZA" and "PAPER BOAT MANGO" beverages showed lower calcium concentrations compared to the previous two beverages but were still within the analysed range.

Potassium (K):

The "PAPER BOAT MANGO" beverage exhibited the highest potassium concentration among the samples, with a mean value of 2.7720 ppm. The "FROOTY" beverage showed the second-highest potassium content, with a mean value of 0.8020 ppm. The "MAZZA" and "SLICE" beverages displayed lower potassium concentrations but were still within the analysed range.

The results indicate that there are variations in the concentrations of sodium, calcium, and potassium among the different beverage samples. The observed differences in mineral concentrations can be attributed to the specific formulations and ingredients used in the production of each beverage.

CONCLUSION

The observed variations in mineral concentrations can be attributed to several factors such as genetic differences among mango varieties, soil composition, geographical location, agricultural practices, and ripeness stages of the fruits. Sodium, calcium, and potassium are essential minerals that play crucial roles in human health. Consumption of fruits, such as mangoes, can contribute to meeting the dietary requirements of these minerals. Furthermore, the mineral composition of mangoes can be relevant for food processing, formulation of mango-based products, and nutritional labelling.

Further studies could focus on exploring the relationship between mineral concentrations and other factors, such as fruit maturity, cultivar-specific differences, and environmental factors. Additionally, it would be valuable to compare the mineral composition of mango fruits with other fruits to gain insights into their relative nutritional profiles.

In conclusion, the analysis of sodium, calcium, and potassium concentrations in mango-based beverages helps to provide a comprehensive understanding of their mineral profiles. This information can contribute to promoting healthier beverage choices and supporting the development of nutritionally balanced products.

Sodium, calcium, and potassium are essential minerals that play important roles in human health. Their presence in beverages, such as mango-based drinks, can contribute to the overall mineral intake. However, it is crucial to consider the recommended daily intakes and balance them with the consumption of other food and beverage sources to maintain a healthy diet.

These findings can be significant for both consumers and manufacturers. Consumers can use the information to make informed choices based on their dietary preferences and nutritional needs. Manufacturers, on the other hand, can use the data to optimize their product formulations and ensure compliance with regulations and nutritional guidelines.

Further studies could focus on analysing a broader range of beverage samples, including different brands and flavours, to understand the variations in mineral content. Additionally, investigating the effects of processing techniques and storage conditions on mineral concentrations in mango beverages would provide valuable insights for the industry.

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