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Sodium and Potassium Intake through Juices and Low Alcohol Beverages in Fiji*

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Abstract

Sixty four different fruit juices, juice concentrates, soft drinks and beers, available in Fiji supermarkets were analysed for Na^+ and K^+ contents with a view to assess their potential for nutritional supplementation or exposure risk in daily life. Drinks fall in five broad categories of (a) fruit based drinks, (b) flavoured artificial drinks, (c) carbonated fizzy drinks, (d) sports drinks and (e) low alcohol drinks. The Na^+, K^+ contents in 100 mL of the drinks were found to be in fruit based drinks (Na^+ 2 - 34 mg, K^+ 84 - 246 mg), flavoured artificial drinks (Na^+ < 1 - 32 mg, K^+ 0 - 59 mg), carbonated fizzy drinks (Na^+ <1 - 15 mg, K^+ 0 - 4 mg), sport drinks (Na^+ 30 - 81 mg, K^+ 0 – 40 mg) and beers (Na^+ 1 - 14 mg, K^+ 23 – 61 mg). All fruit based drinks contained significantly higher amount of potassium as well as lower Na^+/ K^+ ratio. Although Na^+ overload is less likely to arise, except through sports drinks, fruit based drinks and beers could offer appreciable advantage in K^+ supplementation. A shift towards popularization of fruit based drinks through policy decisions and taxation might have beneficial effect in controlling the growing epidemic of hypertension and CHD/CVD events in the long run in the country.

Keywords: *Sodium, Potassium, Juices, Drinks, Beer;* *Supplementary Table S1 – S5 available online.

1. Introduction

A recent report on global burden of diseases emphasized high prevalence of diet-related deaths and disability among adults across the world, particularly being highest in the Oceania region. Among the fifteen causative dietary factors identified in the study, high sodium intake tops the list (Afshin et al., 2019). Sodium (Na^+) and Potassium (K^+) are the principal cations in the maintenance of cellular membrane potential and the osmotic pressure of body fluids (Rehder, 2014). Their intake primarily comes from foods and drinks. Excess consumption of Na^+, inadequate consumption of K^+ and alcohol intake play important role in the pathophysiology of human hypertension (Koliaki and Katsilambros, 2013; Singh and Chandorkar, 2018). Although the exact mechanism how Na^+ increases blood pressure is unclear (Titze and Luft, 2017; Garfinkle, 2017), there exist strong correlation that high intake of Na^+ is associated with development of hypertension, cardiovascular disease (CVD), stroke and kidney diseases (Steffensen et al., 2018), while higher intake of K^+ has been found to exert beneficial effects. An analysis of results from eleven studies, covering 247,510 participants with follow-up of 5 to 19 years showed that people taking 1.64 g per day higher K^+ over the deduced baseline, had 21% lowered the risk of strokes, CHD and CVD events (D'Elia et al., 2011). The increasing prevalence of hypertension not only among adults, but also in children and adolescents is a matter of serious concern (Din-Dzietham et al., 2007 and Lurbe et al., 2009) and alludes to monitoring of visible and invisible sources of Na^+ and K^+ intakes.

World Health Organization (WHO) has recommended a maximum safe intake of Na^+ 2.0 g/day and K^+ 3.5 g/day by an average adults (WHO, 2012; WHO, 2012). However, the total intakes of Na^+ and K^+ in a typical Westernized diet averages 3.4 and 2.8 g/day respectively with average Na^+/K^+ intake ratio of 1.3 (Block et al., 1985; Holbrook et al., 1984). Also the Na+ intake increases faster over K^+ intake with increasing age, thereby creating imbalance in Na^+/K^+ ratio. Frank et al. have shown that between 6 months to 4 years of age Na+ intake increased fourfold while K^+ intake has merely doubled (Frank et al., 1988).

Consumption of processed foods, restaurant foods and takeaways accompanied with artificial juices is rapidly rising in Fiji. With increasing consumption of processed foods and reduction in consumption of fruits and vegetables the Na^+/K^+ intake ratio is getting skewed negatively (He and MacGregor, 2009; EFSA, 2005). Takeaway foods are often accompanied with packaged drinks. In Fiji a wide variety of packaged drinks are sold that are generally imported by a few local supermarket chains, from across the world. The predominant consumers of these drinks are school going children between 5 - 18 years of age. This age group is also more fascinated to fast foods over traditional foods and fresh fruits. This study is aimed to assess potential of these juices on Na^+, K^+ overload as well as to provide a gradation of their Na^+, K^+ contents for nutritional supplementation. Labelling of Na^+, K^+ is not mandatory in Fiji and thus only a few manufacturers label them.

Analytical data about Na^+, K^+ contents for drinks and beverages are scanty. A 1979 Canadian study of about 90 commercial fluids, including soups, juices, flavored drinks and carbonated beverages showed that Na^+ content varied between 0.002 - 5.75 g/L and K^+ contents between 0.00 - 2.54 g/L (Wendland and Arbus, 1979). The citrus juices and juice concentrates showed significantly higher amounts of potassium (Fellers et al., 1990). The variety of juices and beverages have increased tremendously over past four decades, but literature on their Na^+, K^+ profiling are relatively scarce. Children and school goers mostly consume artificial drinks and fruit based drinks while beers drinking is prevalent among adult populations in Fiji. With ever-increasing diversity of juices and drinks, containing artificial and natural ingredients in varying amounts it is imperative to have a factual assessment of their contents. Therefore, this study was aimed at profiling of Na^+, K^+ contents of drinks available in Fiji market for their potential health effects.

2. Materials and Methods

Sodium chloride, potassium chloride, silver nitrate, concentrated nitric acid were purchased from Sigma-Aldrich. Na^+ and K^+ determinations were carried out using microprocessor based Flame Photometer model ESICO 1381. Glassware used in study were soaked in dil. HNO_3 overnight before use. All solutions were prepared in distilled water. Purity of sodium chloride and potassium chloride was determined using gravimetric method (Mendham et al., 2000). Na^+ and K^+ determinations in drink and beverage samples were carried out using standard flame photometric procedures (Mendham et al., 2000).

Na^+ and K^+ stock solutions were prepared by dissolving 1.2740g (0.02180 mol) of sodium chloride and 0.9644 g (0.01294 mol) potassium chloride in 500 mL distilled water to get 1001.7 μg/mL sodium and 1009.7 μg/mL potassium solutions. Working standard solutions were prepared by first diluting the stock solution 25 fold, followed by further dilution of 1.0, 2.0, 3.0, 4.0 and 5.0 mL of the diluted stock solution to 25 mL in standard volumetric flasks. Thus 1.60, 3.21, 4.81, 6.41, 8.01 μg/mL standard sodium solutions and 1.62, 3.23, 4.85, 6.46, 8.08 μg/mL standard potassium stock solutions were used to calibrate the instrument prior to measurements.

Samples were collected from different supermarkets between April - Dec 2017. These supermarkets had shops in all major cities and towns in Fiji. Juices were analysed either after suitable dilutions or neat as appropriate. Carbonated drinks and beer were boiled for 1 min to drive off CO_2 before dilution and analysis. All analyses were carried in triplicate and average values were taken to calculate the amounts present.

3. Results and Discussion

A total of 64 samples representing different brands and sub-types of juices and low alcohol beverages that were commonly sold in super markets in Fiji were collected and analysed. Standard method of analysis was used. Results are presented in Figures 1 – 5 (supplementary Table S1 – S5). To facilitate meaningful comparison results are presented for per 100 mL of the juices and beverages. As some samples consisted of juice or artificial drink concentrates, the tabulated values per 100 mL represent the values in diluted drinks as specified on the packing by the manufacturer.

A recent study on global burden of diseases points to high intake of sodium as a leading risk factor among all fifteen factors studied for food related deaths and disabilities. Risk is the highest in the Oceania region, among adults aged 25 years or older. The intake of sodium mainly comes from foods and drinks. Considering small land area, <20,000 km^2 and a population of less than a million, a surprisingly large variety of drinks and beverages were sold in Fiji. They came from different sources. Some of these were manufactured or packaged locally by local companies viz. Coca Cola Amatil, Punjas and Tappoo, while the vast majority were imported from different countries across the globe viz. Australia, New Zealand, Malaysia, Indonesia, Philippines, Vietnam, China, Sri Lanka, Cyprus, Denmark, USA and Samoa etc. Thus these results reflect to a wider global scenario as well.

Besides the diversity of manufacturing origin, juices and drinks varied in their constitution as well. A majority of them consisted of natural ingredients with proper listing of the principal ingredient, while others were artificially constituted and flavoured. Some of the drinks were special purpose energy drinks meant for the sporting events. It was also noted that some of the juices were misleadingly labelled. Among all juices and beverages analyzed, only a few of them listed Na^+ and K^+ contents.

Most of samples required dilutions to get the values within optimum analysis range of the flame photometer. In addition, the carbonated drinks and beers used to fizz and thereby required preheating to drive off CO_2, before dilutions and measurements. A few juices resisted solubilization upon dilution due to presence of gelatinizing agents and thus were shaken vigorously to ensure homogenization of the diluted samples.

Although labelling of Na^+ and K^+ was not mandatory, some brands displayed one or both values in the nutrient data table. However, the labelled values differed widely from analysis results, except for Powerade, Red Bull and V-energy drinks and Minute Made and Tampico fruit drinks. Beer samples listed Na^+ values more precisely than the fruit juices and other drinks.

3.1. Na^+ and K^+ intake through fruit based drinks

The Na^+, K^+ content in fruit based drinks are shown in Figure 1 (Table S1). Analysis results indicated that all fruit based drinks had significantly higher K^+ than other drinks. In fact, K^+/Na^+ ratio could be used as a rough indicator for quantification of natural ingredient in a drink.

Among the natural fruit based drinks, except those containing citrus, orange or mango all others contained much lower Na^+ that ranged below 15 mg/100 mL, while K^+ contents ranged between 84 – 246 mg/100 mL (Figure 1). It appears that excess salt was added during processing to suppress sourness in citrus and orange-based drinks. Particularly, the drinks with high K^+ content were Golden Circle (Orange), Macro Organic 100% Pure Coconut Water, Golden Circle (Pineapple), Fresh n Juicy (Orange), Just Juice (Pineapple & Guava), Apple & Eve (Very Berry), Fontana (Orange), Just Juice (Orange & Mango), Apple & Eve (Fruit Punch), Fontana (Apple Juice), Golden Circle (Tropical Punch), Real Fruit Juice (Orange), Fresh n Juicy (Apple) in that order (Figure 1).

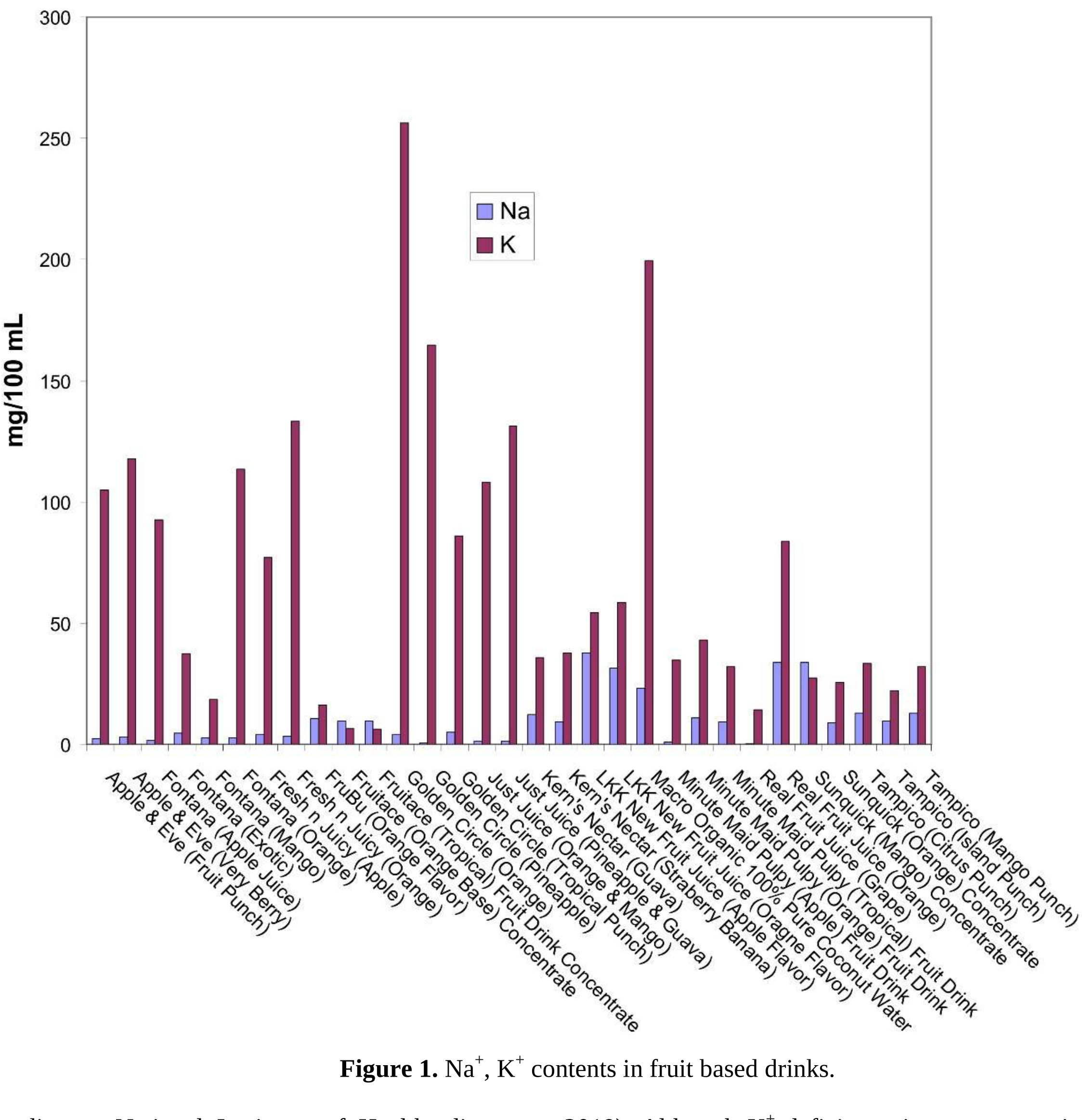

Figure 1. Na^+, K^+ contents in fruit based drinks.

According to National Institutes of Health, dietary requirement of K^+ of an average adult is 3,400 and 2,600 mg/day for males and females, respectively. Nursing mothers require slightly higher amount of potassium 2,800 mg/day, while infants and young children require between 400 - 2,500 mg/day (NASEM, 2019). Although K^+ deficiency is uncommon, it might occur in persons with profuse sweating, in diarrhoeal disorders, Inflammatory Bowel Disease, dialysis, use of diuretics and laxatives and persistent eating pica (Viera and Wouk, 2015; McKenna, 2006). Hypokalemia is characterized by bloating, muscle weakness, fatigue, abdominal pain, cramping and constipation and might lead to potentially fatal heart arrhythmia especially in individuals with underlying heart disease (Zieg et al., 2016; Preuss and Clouatre, 2012). This study indicates that higher K^+ requirements can effectively be supplemented through appropriate choice of fruit based drinks.

3.2. Na^+ and K^+ intake through flavoured artificial drinks

The Na^+, K^+ content in flavoured artificial drinks are shown in Figure 2 (Table S2). Values found to be negligibly small in the two local brands, viz Punjas and Tuckers. Rebena and LKK brands did show moderately higher amounts of Na^+ and K^+, both. Particularly in LKK brand samples higher amounts Na^+ (29.5 - 37.8 mg/100 mL) and K^+ (47.0 - 58.0 mg/100mL) were observed. However, it could not be ascertained if higher amounts of K^+ were due to any natural ingredients or due to additives, as information about ingredients were not given. They appeared to be synthetic gels of moderate consistency and hence required vigorous shaking for homogenization during dilutions.

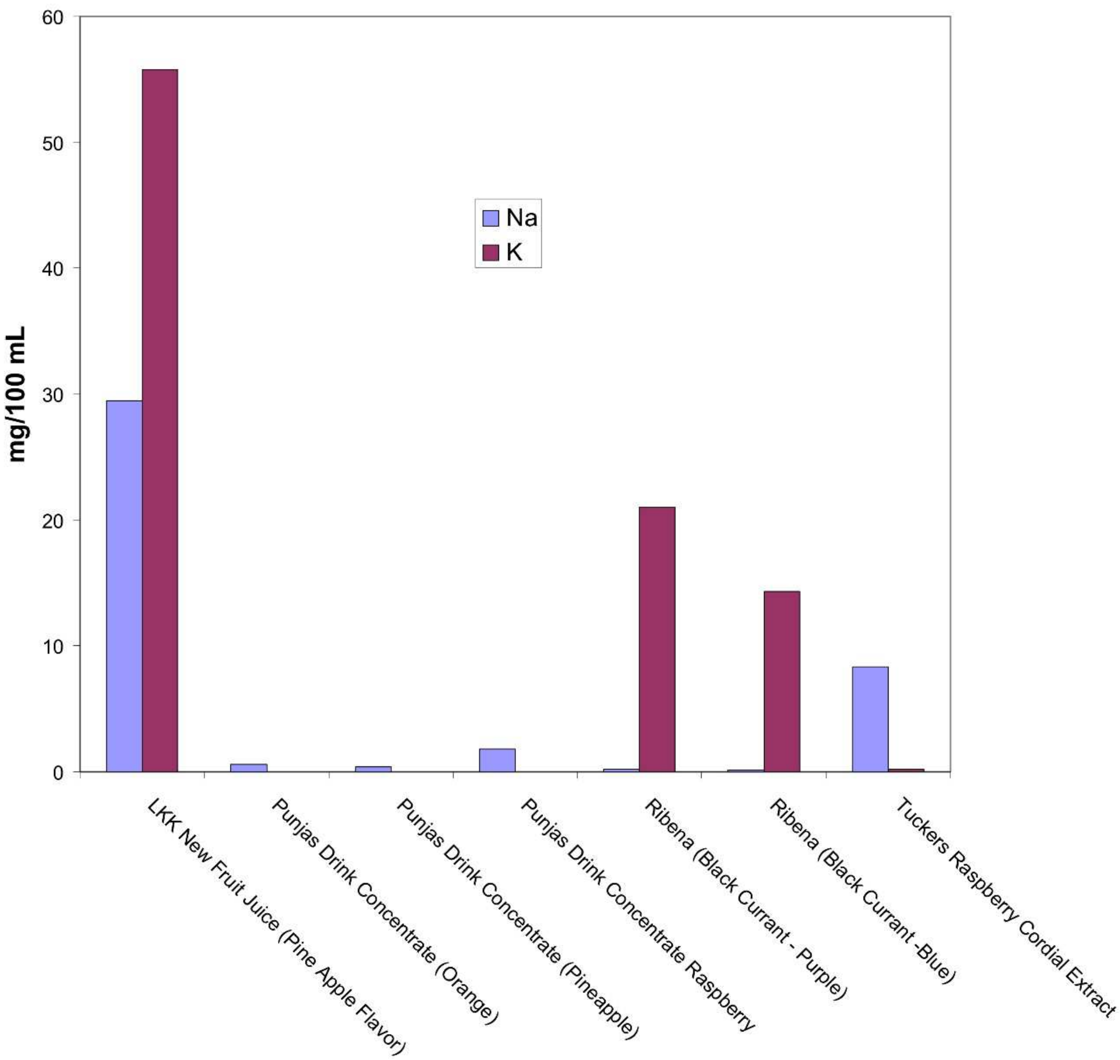

Figure 2. Na^+, K^+ contents in flavoured artificial drinks.

3.3. Na^+ and K^+ intake through carbonated fizzy drinks

The Na^+, K^+ contents in carbonated drinks is graphically shown in Figure 3 (Table S3). Among the carbonated drinks, particularly 7UP Lamonade and Sprite Lamonade contained 14.6 and 8.3 mg/100 mL Na^+ respectively with negligibly low amounts of K^+, while others contained <4.2 mg/100mL of Na^+. Apparently, excess salt was added to suppress sourness in the lemonades. Sodium overload is less likely to arise from these carbonated drinks when consumed in moderate amounts.

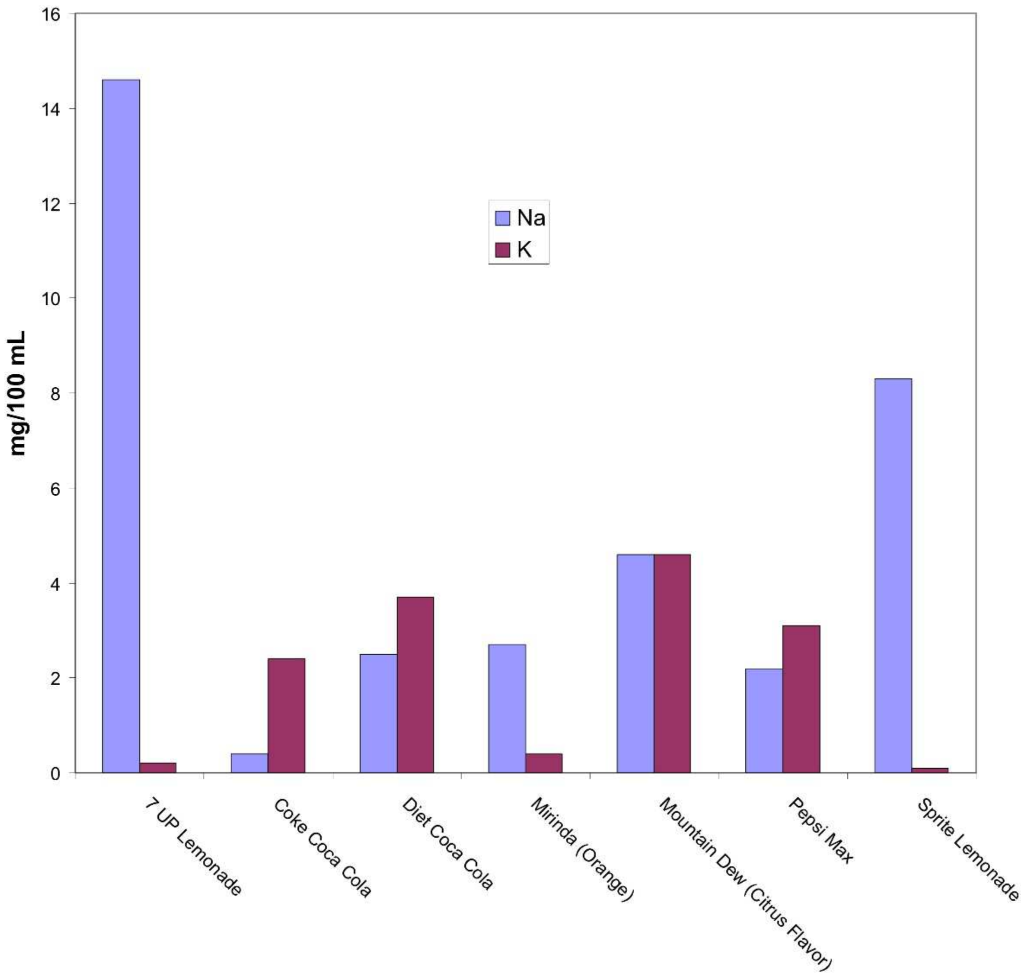

Figure 3. Sodium, potassium contents in carbonated fizzy drinks.

3.4. Na^+ and K^+ intake through sports drinks

The Na^+, K^+ content in sports drinks are shown in Figure 4 (Table S4). The Na^+ content in rehydrating energy drinks, particularly V-drinks were found to be significantly higher 71.4 and 81.3 mg/100 mL. Other rehydrating drinks Redbull and Powerade contained nearly half of the amount of Na^+ as compared to that in V-drink that range between 30 – 36 mg/100 mL. Powerade drinks also contained significant amounts of K^+ (34 and 40 mg/100 mL). Considering greater excretion of Na^+ (90 mg/100 mL) than K^+ (40 mg/100 mL) through sweating during strenuous exercises (Montain et al., 2007; Verde et al., 1982), these drinks are suitable for special purpose consumption only.

3.5. Na^+ and K^+ intake through low alcohol drinks

The Na^+, K^+ content in beers are shown in Figure 5 (Table S5). Most of the beers were low in Na^+, but contained reasonably good amounts of K^+. The Na^+ content in all beer samples except Victoria beer and ginger beer were found to be less than 10 mg/100 mL while K^+ contents varied in the range 29.3 - 58.8 mg/100 mL. The K^+ contents were found in order Peroni (1948) Nastro Azzurro > Fiji Premium > Vailima Lager > Victoria Bitter > Heineker Lager > Vailima Pure Lager > Fiji Bitter > Foster's Lager > Pure Blonde > Fiji Gold beers. Peroni and Fiji Premium brands had the highest amounts of K^+. Higher amount of K^+ in beers is likely to arise from natural ingredients used in their manufacture.

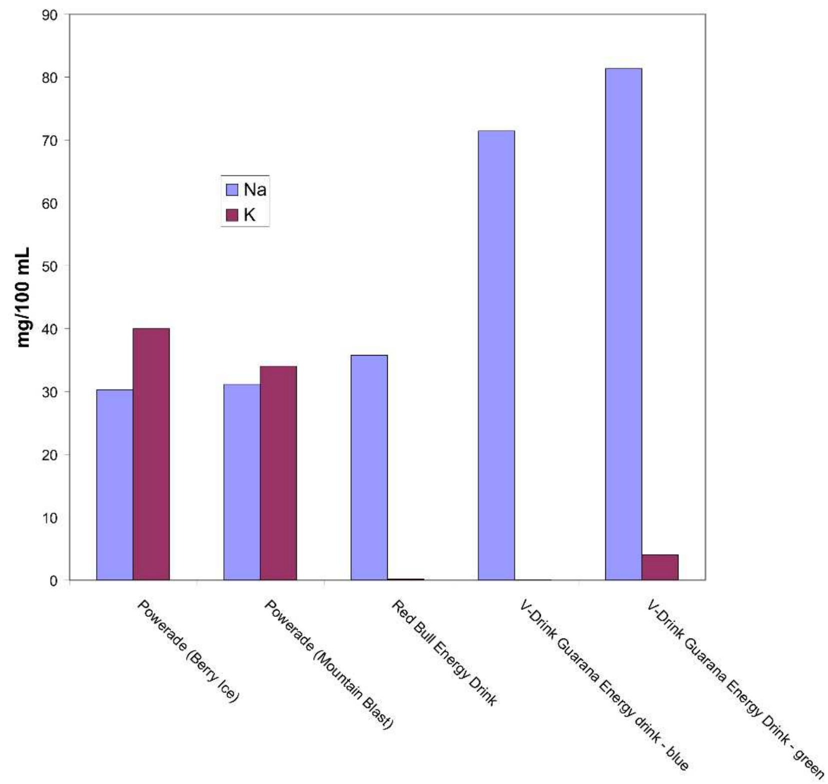

Figure 4. Na^+, K^+ contents in sports drinks.

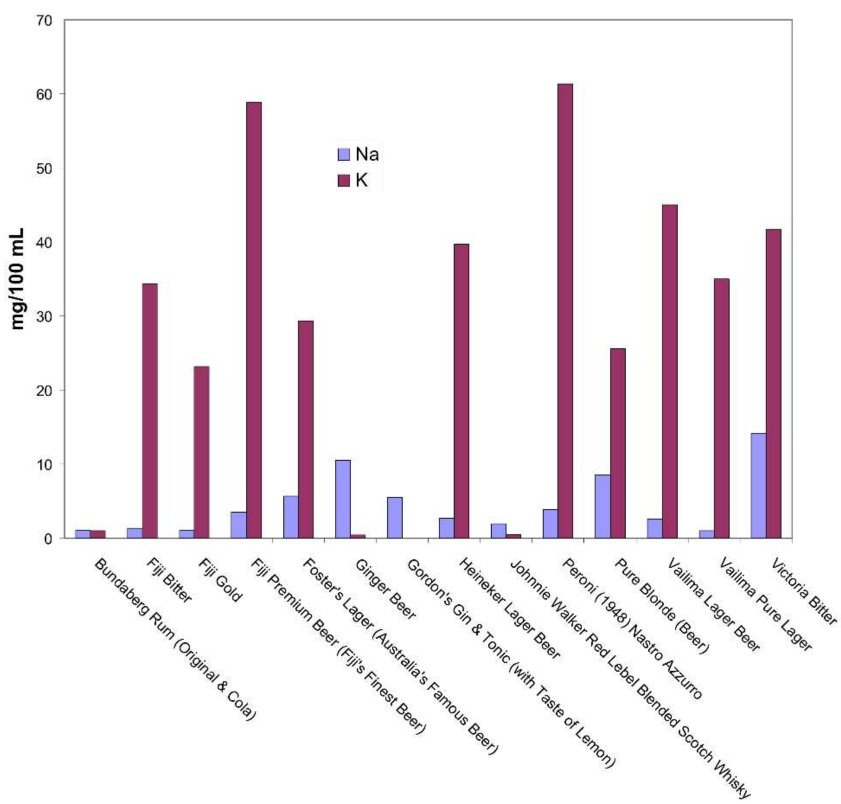

Figure 5. Na^+, K^+ contents in low alcohol drinks.

Beer drinking is quite common in Fiji among adult population. Often 2 - 3 liters are consumed by an adult. The accumulated effect in such heavy beer drinkers might be significant. Subjects consuming large amount of beer with little or no ordinary food intake are likely to suffer with electrolyte imbalance arising from hyponatraemia. The incidences of hypokalemia, hyponatremia coupled with low production of urea are not uncommon among heavy beer drinkers (Hilden and Svendsen, 1975).

4. Conclusions

A very wide variety of fruit based drinks and concentrates, carbonated drinks, artificially flavoured drinks and beers were retailed in Fiji market. Majority of them were imported from across the globe. The Na^+ content in most of these drinks had been of the same order as in tap water (~ 19 mg/L), except the energy drinks. All of the carbonated drinks, artificially flavoured drinks were low in K^+, but invariably all fruit based drinks were found to contain higher amount of K^+ and lower Na^+/K^+ ratio. The energy/sports drinks also contained higher mineral contents, but comparing costs vis-a-vis fruit based packaged drinks, the latter should be a better alternative for electrolyte supplementation in homes and during sporting events. Oceania region including Fiji is identified as one of the high Na^+ intake and high mortality region arising from cardiac and CVD events. Finding indicate that imbalance in Na^+, K^+ intake can partly be corrected through use of fruit based drinks. Results might be useful to dieticians and nutritionist while recommending drinks for sickly people or for supplementation purposes, and for policy makers to be watchful of these ready to drinks of their Na^+, K^+ contents to stem growing epidemic of hypertension. A shift towards popularization of fruit based drinks through policy decisions and taxation might have beneficial effect on controlling epidemic of hypertension, CHD and CVD events in the long run.

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