

Impact of Consumption of Certain Electrolyte Rich Natural Products on the Serum Na⁺ and K⁺ Profile, Anemia and Iodine Nutriture in Desert Population of Rajasthan

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ABSTRACT To observe the impact of supplementation of some electrolyte rich natural products on the Serum Na⁺ and K⁺ profile, anemia and iodine nutriture in desert population. Double blind randomized controlled trial conducted to test the efficacy of two natural products, that is, Tender Coconut Water and Ash Gourd juice separately. A total of 390 adults (15-45 years) were registered and categorized into three groups for supplementation of these products and examined serum Na⁺ and K⁺, hemoglobin, Urinary Iodine, morbidities. A significant increase in serum K⁺ was observed 65.0 and 61.6 percent in case of tender coconut water and ash gourd juice respectively as both products have rich natural source of potassium (P< 0.05). The increase in case of serum Na was recorded 53.4 and 48.8 percent, in tender coconut water and ash gourd respectively. The supplementation of these electrolyte products exhibited positive effect on mineral profile, that is, serum K⁺ and serum Na⁺, along with iodine nutriture, and general health profile especially gastritis and muscle weakness in rural adults. The supplementation also improved haemoglobin levels and declined anemia significantly. The electrolyte rich natural products can also be included, in the current national programs which will be helpful to health functionaries in designing operational pack rations for army *jawan* and residents of desert area.

INTRODUCTION

The residents of the Thar (Central Arid Zone Research Institute 2001) desert areas experience constant state of stress due to extreme environmental conditions, which in turn affect their mineral (K⁺, Na⁺) and general health profiles. Tender coconut water is refreshing drink with electrolyte similar to human plasma and the mineral composition and reasonable total sugar content make coconut water a natural isotonic sports drink (Priya and Ramaswami 2014). Electrolytes (Nair and Kalyanasundaram 1999; Srilakshmi 2002), particularly Potassium and sodium (K⁺, Na⁺) are important constituents of fluid present outside and within the cells. Proper concentration of these electrolytes inside and outside the cell is essential to maintain osmotic balance and

keep cells in proper shape. Slight changes in the blood concentrations of the important minerals may rapidly endanger the life. Sodium is concerned in the maintenance of fluid balance, muscle irritability, acid base balance and osmotic pressure. Sodium is lost through urine and sweat as sodium chloride. Sweat contains 0.1 to 0.3 percent sodium chloride. In hot weather, with excessive sweating, as much as 5 g sodium may be lost daily through sweat. Pure sodium deficiency causes weakness, giddiness, anorexia, cramps in the muscles, which are exercised the most (mainly calf muscles), twitching and convulsions, collapsed veins, cold extremities, and low blood pressure. Associated water deficiency is common, which produces, in addition to above, scanty urine, dry mouth, inelastic skin, and disorientation. Acute depletion of sodium by 30 percent will lead to circulatory collapse and death. Sodium loss through profuse sweating causes sodium deficiency which poses a problem among heavy manual workers and stokers. They suffer ill-health, lassitude and fatigue, leading to lack of enthusiasm. Potassium is concerned with cellular excitability. The irritability of the nerves and skeletal and heart muscles is determined by the relative amounts of potassi-

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um, calcium and magnesium. Muscular irritability is increased by increase in potassium or diminution of calcium and magnesium. potassium is also necessary for the maintenance of acid-base balance. Relationship between iodine loss and iodine deficiency is also reported in literature (Mao et al. 2001) during electrolyte loss from profuse sweating in hot environment.

The coconut water lowered the heart rate frequency better than the isotonic drink (Syafriani et al. 2012). In vitro, tender coconut water is a rich source of antioxidants (Vishakh et al. 2014) and found to exert beneficial effects on electrolyte imbalance and elevated plasma rennin activity and aldosterone level in fructose fed hypertensive rats (Bhagya et al. 2010). The supplementation of ash gourd fermented beverage showed significant improvement in haemoglobin and lipid profile (Devaki and Premavalli 2012).

In Thar (Central Arid Zone Research Institute 2001) desert, summer temperature remains high, reaching up to 50°C in May and June in some places and represent arid to hyper arid conditions. The annual precipitation is low and residents have to face these harsh environmental conditions. There is a research question that what is effectiveness of some natural rich electrolyte products on mineral profile of desert population as they are being exposed to harsh environmental conditions especially high temperature. Hypothesis was 'Consumption of some electrolyte rich natural products will enhance mineral profile (K⁺, Na⁺) in human blood samples of adults in desert areas of Rajasthan'.

Objective of the Study

The present study was conducted with the primary objective to observe the effectiveness of supplementation of the these electrolyte products on serum Na⁺ and K⁺ along with secondary objective to study their effect on iodine nutrition, anemia and general health profile. In Rajasthan state of India (Census 1994), there are 32 districts out of which 12 districts represent Thar desert.

MATERIAL AND METHODS

Three products were considered in the study. Two natural rich electrolyte products, that is, tender coconut water and ash gourd juice were developed and supplied by the Defence Food

Research Laboratory, Mysore, and third one mineral water.

Study Design

Double blind randomized controlled trial was conducted to test the efficacy of the these products, that is, Group one- tender coconut water and group two- ash gourd juice and Group three- mineral water independently. A household (HHs) served as one single unit for the purpose of administration of products. Each HHs under study was followed up to two months.

Sampling

Sample size was calculated on the basis of the reported 40 percent prevalence of Micronutrient Deficiency Disorders based on Urinary Iodine Excretory level (UIE levels) in desert area (Singh et al. 2009), (as no other record was available) and selected 112 HHs for administration of one product, however, when allowed non-response error, the no. became 130 HHs. It was proposed to select 2 villages forming a contiguous field in rural part of Jodhpur, a desert district. Two villages, that is, Salwa and Kharwali forming a contiguous field were selected randomly. The HHs of these villages first listed fully, then allocated randomly in to three groups. Each group was then administered one product. Norms of double blind trial were adhered to. The three products were in similar packing and of same colour and appearance. Information for demographic and socio-economic aspects was collected. Before and after supplementation, all the enrolled adults were examined for the general health profile, that is, morbidity profile for last 15 days with special emphasis on gastritis, muscle weakness, burning of foot, over breathing, muscle irritability, UTI and thirstiness. For these subjective symptoms, grades were used.

Blood samples were collected for estimation of mineral profile of Na⁺ and K⁺ in laboratory by flame photometer. At the time of collection of blood, 20 ml blood was taken on Whatmen filter paper No. 1 for estimation of Hemoglobin levels. Hemoglobin levels were estimated using Cyanmethaemoglobin technique and classified according to WHO classification. Casual urine sample were collected for estimation of Urinary Iodine Excretion (UIE) levels. Iodine was deter-

mined by WET digestion method using standard laboratory technique (Dunn et al. 1993). UIE level less than 100 mcg/l have been considered as indicator of iodine deficient nutriture.

In this study, 390 adults (15-45 years) were registered (who agreed to follow the instructions) and categorized into three groups for supplementation of three products (Table 1). The data was collected on all the parameters mentioned above from all the enrolled volunteers before initiation and after the completion of the supplementation. These villages were visited to supply the products to all enrolled adults for two months. All the registered adults were instructed to consume one bottle (200 ml) of electrolyte products empty stomach early in the morning every day. They have been instructed that they should not consume anything up to half an hour after consumption of the electrolyte product and should not share the supplement with other family members. Compliance was monitored daily by the local *Aganwari* workers available at village level. Data was collected by trained team composing of Physician, Field investigator (Nutrition), technician and nurse.

Data collected in the field was computerized under the supervision of biostatistician and analyzed using FOX- PRO and EPI-INFO-2002 software. As regards to the specific analysis, the extent of increase in mineral profile of Na⁺ and K⁺ in serum were carried out and the same were compared before and after the supplementation of the products using students t-test in order to observe its impact. Statistical test (Snedecor and Cochran 1967) of significance was applied in other associated parameters such as Anemia, UIE and Morbidities in order to observe the impact of electrolyte products.

This project was submitted to, and approved by, Scientific Advisory Committee (an institutional review board or committee) and Ethical Committee of Desert Medicine Research Centre, Jodhpur.

RESULTS

After the completion of the supplementation program in this area, the overall non response was 17.7 percent. Non- response for tender coconut water, ash gourd juice and mineral water was reported to be 17.4, 21.1 and 14.4 percent, respectively. A total of 321 adults were examined for all parameters after intervention. Reasons for non- response were ‘non co-operation’, ‘not good taste’ and ‘gone outside due to urgent work’. Even in these 321, 45 adults refused to give their blood sample due to fear.

Illiteracy was high among female volunteers that is ranging from 65.2 to 68.7 percent, whereas, in case of males, ranged from 18.4 to 25 percent. Population belonging to LIG and low MIG group were 13.6 and 25.9 percent respectively.

Distribution of adults according to percent increase in serum K⁺ before and after supplementation of tender coconut water, ash gourd juice and mineral water is shown in Table 2. Overall increase in serum K⁺ was 65.0 percent, which is significantly higher than decrease (P<0.05) in case of tender coconut water. Increase was 69.6 percent in males and 62.9 percent in females. Overall increase was 61.6 percent, significantly higher than decrease (P<0.05) in case of ash gourd juice. Increase was higher in females, that is, 64.3 percent as compare to males (56.7 %). Increase was also observed in case of mineral water (70.1%). The percent increase in serum K⁺

Table 1: Sex wise distribution of population covered before and after supplementation

No.	Product No. 1 <i>Tender coconut water</i>			Product No. 2 <i>Ash gourd</i>			Product No. 3 <i>Mineral water</i>		
	M	F	T	M	F	T	M	F	T
<i>Before Supplementation</i> N=390	49	95	144	48	80	128	49	69	118
<i>After Supplementation</i> N=321	40	79	119	36	65	101	39	62	101
<i>Covered For Blood After Supplementation</i> N=276	33	70	103	30	56	86	31	56	87

Table 2: Distribution of population according to percent increase in Serum K⁺ and Na⁺ before and after supplementation in different products

Product No.	Male		Female		Pooled	
	Decreased	Increased	Decreased	Increased	Decreased	Increased
<i>Percent Increase in Serum K⁺</i>						
Product No. 1	30.3	69.7**	37.1	62.9**	35.0	65.0**
Product No. 2	43.3	56.7	35.7	64.3*	38.4	61.6*
Product No. 3	32.3	67.7	28.6	71.4**	29.9	70.1**
<i>Percent Increase in Serum Na⁺</i>						
Product No. 1	48.5	51.5	45.7	54.3	46.6	53.4
Product No. 2	60	40	46.4	53.6	51.2	48.8
Product No. 3	35.5	64.5	48.2	51.8	43.7	56.3

*P<0.05 ** P<0.01

before and after supplementation was observed mainly in the range of 0 to 5 mEq/l in all three products.

Table 3 exhibits the overall increase in mean values of serum K⁺ before and after supplementation. Overall mean value of serum K was found to be raised from 5.06 to 5.23 mEq/l in case of tender coconut water, 5.01 to 5.17 mEq/l in case of ash gourd juice and from 5.05 to 5.22 mEq/l in case of mineral water. In case of tender coconut water, the increase in mean values was recorded more in males than females.

Tables 2 exhibits the distribution of adults according to percent increase in serum Na⁺ before and after supplementation of three products. Overall, 53.4 percent adults showed increase in serum Na⁺ in case of tender coconut water. In case of ash gourd juice, increase was observed only in 48.8 percent adults and increase was observed more in case of females (53.6 %) than males (40.0 %). In case of mineral

water, increase was recorded in 56.3 percent adults. In tender coconut water, maximum increase in serum Na⁺ was recorded in the range of 5 to 10 mEq/l (19.4%), followed by >10.0 mEq/l (17.5 %), whereas, in case of ash gourd juice, maximum rise was recorded in >10.0 mEq/l range (18.6 %). In case of mineral water, the maximum increase was recorded only in the range of 0 to 5 mEq/l (25.3 %).

Table 3 exhibits overall increase of mean value of serum Na⁺, which ranged from 136.42 to 139.02 mEq/l in case of tender coconut water, whereas from 136.9 to 137.43 mEq/l in product No. 2 that is ash gourd. No change was observed in case of mineral water. Overall increase in mean value of serum Na⁺ was observed more in case of tender coconut water that is 2.60 mEq/l in comparison to ash gourd (0.44 mEq/l).

Data on the anemia based on Hb estimation has been shown in Table 4. In case of tender coconut water, a significant decline of anemia

Table 3: Distribution of population according to mean values in serum K before and after supplementation in different products

	Mean values of serum - K Before supplementation (mEq / l)			Mean values of serum - K After supplementation (mEq / l)		
	Male	Female	Pool	Male	Female	Pool
Product No. 1	4.99±0.79	5.1± 0.81	5.06± 0.80	5.20±0.24	5.24±0.70	5.23±0.59
Product No. 2	5.17±0.38	5.06± 0.54	5.01± 0.49	5.20±0.18	5.16±0.46	5.17*±0.40
Product No. 3	4.95±0.61	5.11± 0.50	5.05± 0.55	5.22±0.50	5.23±0.53	5.22±0.52
	Mean values of serum - Na Before supplementation (mEq / l)			Mean values of serum - Na After supplementation (mEq / l)		
Product No. 1	136.19±16.31	136.53± 18.64	136.42±17.84	139.0± 7.91	139.04± 8.20	139.02± 8.07
Product No. 2	138.4± 7.58	136.24± 10.47	136.99± 9.57	136.16± 8.41	138.12±10.81	137.43±10.03
Product No. 3	138.29± 5.82	138.61± 8.92	138.9± 7.92	137.65±11.13	139.56±14.07	138.88±13.06

*P<0.05

Table 4: Distribution of population according to anemia (Haemoglobin Estimation) before and after supplementation in different products

<i>Anemic in products</i>	<i>Male(Hb < 13 g/dl)</i>		<i>Female(Hb < 12 g/dl)</i>		<i>Pool</i>	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Product No. 1	46.5	18.2	67.5	43.1*	60.5	34.5**
Product No. 2	54.8	29.4	63.4	35.0*	60.2	33.0*
Product No. 3	43.5	13.9	63.1	32.8*	55.0	25.5*

* P<0.05 **P<0.01

(Hb <13 mg/dl in males and Hb <12 mg/dl in females) was observed that is from 60.5 percent to 34.5 percent (P<0.01). The percentage of non-anemic adults before and after supplementation was observed to be 39.5 and 65.5 percent respectively. In case of ash gourd juice, overall anemia declined from 60.2 to 33.0 percent (P<0.05). Overall anemia was recorded declined in case of both males and females. The percentage of non-anemic adults before and after supplementation was observed to be 39.8 and 67.0 percent, respectively. In case of mineral water too, anemia was found to be declined from 55.0 to 25.5 percent.

Estimation of Urinary Iodine Excretion (UIE) level has been shown in Table 5. The percentage of adults deficient in UIE levels was recorded to be declined significantly from 61.1 to 22.6 percent (P<0.001) in case of tender coconut water. In case of ash gourd juice, decline was observed from 63.1 to 13.8 percent, which was found statistically significant (P<0.001). Decline was significant both in males and females. In case of mineral water the decline was recorded from 64.3 to 18.6 percent.

All the registered volunteers were examined before and after supplementation, for their general health profile that is morbidities for last 15 days with special emphasis on gastritis, muscle weakness, burning of foot, over breathing, muscle irritability, UTI and thirstiness. The study

revealed that the percentage of gastritis declined from 52.1 to 40.3 percent and the decline was recorded more in males (16.9%) than females (9.1%), but statistically insignificant in case of tender coconut water. In case of ash gourd juice, the decline was recorded from 50.0 to 29.7 percent, which was statistically significant (P<0.05), in both males and females. In case of mineral water, the decline was recorded from 52.5 to 34.7 percent, but statistically insignificant.

Muscle weakness was recorded declined significantly, from 42.1 to 30.4 percent in females (P<0.01), whereas, overall decrease was recorded from 37.5 to 24.4 percent in case of tender coconut water. In case of ash gourd juice, the decline was recorded from 38.3 to 21.8 percent, whereas, in case of mineral water, it was recorded declined from 37.3 to 33.7 percent, but statistically insignificant.

Overall burning of foot was observed declined from 34.1 to 11.8 percent, 28.9 to 17.8 percent and 26.3 to 22.8 percent in case of tender coconut water, ash gourd juice and mineral water, respectively, however, the decline was found to be statistically insignificant. Over breathing was found declined from 22.2 to 5.0 percent, 25.0 to 5.0 percent and 18.6 to 6.9 percent in case of tender coconut water, ash gourd juice and mineral water, respectively, but statistically insignificant. Muscle irritability was also observed declined from 37.5 to 22.7 percent, 29.7 to 16.8

Table 5: Distribution of population according to deficient urinary iodine levels before and after supplementation in different products

<i>UIE level deficient (< 100 µg/l)</i>	<i>Malepercent</i>		<i>Femalepercent</i>		<i>Total percent</i>	
	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>	<i>Before</i>	<i>After</i>
Product No. 1	69.4	22.5*	56.8	22.7*	61.1	22.6***
Product No. 2	70.2	9.4*	58.7	16.1*	63.1	13.8***
Product No. 3	61.2	15.4*	66.7	20.7**	64.3	18.6***

* P<0.05 ** P<0.01 *** P<0.001

percent and 42.4 to 26.7 percent in case of tender coconut water, ash gourd juice and mineral water, respectively, but statistically insignificant. Overall, Urinary Tract Infection (UTI) was found to be declined from 34.7 to 16.0 percent in case of tender coconut water, 37.5 to 12.9 percent in case of ash gourd juice and 27.1 to 17.8 percent in case of mineral water, respectively, but statistically insignificant. The percentage of thirstiness was also observed declined significantly in case of males, from 97.2 to 80.6 percent for ash gourd juice ($P < 0.05$), whereas, overall decline was observed to be 87.1 to 83.2 percent, but statistically insignificant. No significant change was observed in case of tender coconut water and mineral water.

DISCUSSION

Study revealed that electrolyte products had positive effect on increase of serum K^+ in adults of this area and overall significant increase in serum K^+ was observed in case of tender coconut water (65.0 %) and ash gourd juice (61.6 %), as both the products are rich in natural source of potassium (290 mg%) in tender coconut water and 12 mg% in ash gourd juice as reported by Coconut Board. Most of the adults showed increase in serum K^+ in the range of 0 to 5 mEq/l in case of all the three products. Overall increase in mean values of serum K^+ before and after supplementation was observed in case of tender coconut water (from 5.06 to 5.23 mEq/l), ash gourd juice (5.01 to 5.17 mEq/l) and mineral water (5.05 to 5.22 mEq/l). In case of tender coconut water, increase in mean values was observed more in males as compared to females.

Supplementation of test electrolyte products enhanced Na^+ in serum after supplementation. Overall increase was seen in 53.4 percent, in case of tender coconut water and 48.8 percent in case of ash gourd juice. Maximum increase in serum Na^+ was in the range of 5 to 10 mEq/l (19.4 %) followed by ≥ 10 mEq/l (17.5 %) in case of tender coconut water, whereas, in case of ash gourd juice, it was in ≥ 10 mEq/l range (18.6 %). Increase was also seen in case of mineral water, which may be due to the fact that adults of this area never take mineral water in their routine life. They mostly drink tanks/ pond water and some times tap water. But maximum increase of serum Na^+ was only in the range of 0 to 5 mEq/l (25.3 %). Increase in mean values of serum Na^+ after

supplementation was also observed in case of tender coconut water and ash gourd juice but no change was observed in case of mineral water. In an earlier study (Priya and Ramaswami 2014), tender coconut water was found high in electrolyte content and reported as an isotonic beverage due to its balanced electrolytes like sodium and potassium that help to restore losses of electrolytes through skin and urinary pathways. In another study (Bhagya et al. 2010) tender coconut water was found to exert beneficial effects on electrolyte imbalance and elevated plasma rennin activity and aldosterone level in fructose fed hypertensive rats. In another study (Baker et. al. 2008) carried-out on athletes, it was reported that overall Na^+ consumption attenuated the decline in $S_{[Na^+]}$ ($\geq 2.0 \pm 0.5$, $\geq 0.9 \pm 0.5$, $\geq 0.5 \pm 0.5$ mmol/l from pre- to post experiment of the 0% ABM trials for Na^+30 , Na^+18 , and Na^+0 , respectively). In another study (Mao et al. 2001), it has been reported that there is electrolyte loss in sweat and iodine deficiency in a hot environment. In desert area, conditions are very harsh and the residents have to face constant state of stress due to extreme environmental conditions of desert area which in turn affects the mineral (K^+ , Na^+) and general health profile as potassium and sodium are important constituents of fluid present outside and within the cell. Slight changes in the blood concentrations of the important minerals may rapidly endanger the life. In hot weather, with excessive sweating, as much as 5 g sodium may be lost daily through sweat may lead to sodium deficiency. Significant positive correlations of daily Na^+ and K^+ intakes with output were observed (Frank et al. 1983) with higher correlation for K^+ than Na^+ . In desert area, nutraceuticals based on carbohydrate, fatty acids and minerals are relatively more suitable and ready-to-drink products among processed foods.

The impact of supplementation of electrolyte products also had positive effect on enhancing the haemoglobin values of adults that is reducing the percentage of anemia after supplementation. Significant decline of anemia was observed ($P < 0.01$) in case of tender coconut water, ash gourd juice and mineral water. Decline was observed both in males and females. These results are very much encouraging as very little research work has been carried-out in this area to observe the in-direct association between electrolyte balance and anemia. Earlier study

(Devaki and Premavalli 2012) reported that the supplementation of ash gourd fermented beverage showed significant improvement in haemoglobin and reduced anemia from 38.5 percent to 23.5 percent in geriatric population. In another study (Milesi et al. 2009), it was reported that in desert area, heat dissipation during work is one of the major problems faced which is exhibited in sweat formation. Sweating leads to tiredness, dehydration, loss of minerals, specifically potassium, zinc, iron and iodine which calls for energized, micronutrient rich foods.

Electrolyte products supplementation also had positive effect on iodine nutriture of registered adults. The percentage of adults deficient in UIE levels declined significantly ($P<0.001$) in case of tender coconut water and ash gourd juice. Decline was significant in case of both males and females. Electrolyte loss from profuse sweating in soccer-team players were studied (Mao et al. 2001) and evaluated the relationship between this source of iodine and iodine deficiency. Urinary iodine was significantly ($P<0.02$) lower than the normal level of 50 microg/gm creatinine in 38.5 percent of the soccer players, compared with 2.0 percent of the sedentary students. The result of the study suggest that loss of iodine though profuse sweating may lead to iodine deficiency, and loss of electrolytes through sweating may have a dietary significance for heat-stressed individuals or for individuals who perform heavy workloads. This study showed that there is also loss of urinary iodine along with other electrolytes to which attention is required.

The supplementation of electrolyte products also had positive effect on general health profile that is morbidities for last 15 days with special emphasis on gastritis, muscle weakness, burning of foot, over breathing, muscle irritability, UIT and thirstiness which are the signs associated with Na^+ and K^+ deficiencies (Nair and Kalyanasundaram 1999; Srilakshmi 2002). Gastritis declined significantly ($P<0.05$) both in males and females in case of ash gourd juice, whereas, in case of tender coconut water, decline was observed, but statistically insignificant. Muscle weakness declined significantly in females ($P<0.01$), whereas, overall decrease was observed from 37.5 to 24.4 percent in case of tender coconut water and 38.3 to 21.8 percent in case of ash gourd juice, but statistically insignificant. The percentage of thirstiness declined

significantly among males in case of ash gourd juice ($P<0.05$). It has been reported (Milesi et al. 2009) earlier also that an oral supplementation with a proprietary melon juice concentrate rich in SOD may have positive effect on several signs and symptoms of perceived stress and fatigue. In one of the earlier study it was reported that the coconut water lowered the heart rate frequency better than the isotonic drink (Syafriani et al. 2012). *In vitro* study (Vishakh et al. 2014) also proved that tender coconut water is a rich source of antioxidants and phenolic compounds and on the other hand is a cytokine abundantly found in tender coconut water had shown significant anti-ageing, anti-carcinogenic, and anti-thrombotic effects.

Electrolytes (Nair and Kalyanasundaram 1999; Srilakshmi B 2002) particularly potassium and sodium (K^+ , Na^+) are important constituents of fluid present outside and within the cell. Slight changes in the blood concentrations of the important minerals may rapidly endanger the life.

CONCLUSION

The supplementation of electrolyte products had positive effect on mineral profile, that is, serum K and serum Na in rural adults residing in desert areas of Rajasthan who are in a constant state of stress due to extreme environmental conditions of desert. The tender coconut water and ash gourd juice were both rich in natural source of potassium and sodium due to which their supplementation had positive effect on mineral profile that is serum K^+ and serum Na^+ along with iodine nutriture, and general health profile, especially gastritis and muscle weakness in rural adults residing in desert areas of Rajasthan. In addition, the findings have special reference with respect to army personnel, being posted on boarders in desert areas. These products, rich in natural electrolytes, had also helped in improving the haemoglobin levels and declined Anemia significantly in adults of the desert areas.

RECOMMENDATIONS

The findings suggest that the electrolytes can also be included, in the ongoing nutrition supplementation national programmes in these areas. These results will also help the health

functionaries in designing operational pack rations for residents of this area and army personnel posted in borders of desert areas. Study suggests large scale field trial to validate/strengthen these findings in desert area.

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