

Comparitive Study on Coconut Water, Carbohydrate Electrolyte Sports Drink and Sodium Enriched Coconut Drink on Measures of Hydration and Physical Performance in Athletes

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Abstract: Coconut water which contain sodium, chloride, potassium and glucose as a rehydration fluid. Recently, attention has been given to coconut water, a natural attentive to manufactured sports drink, within initial evidence indicating efficacy with regard to maintaining hydration. The study aim to compare coconut water, sodium enriched coconut water and carbohydrate electrolyte sport drink and sodium enriched coconut drink on measures of hydration and physical performance of athletes. This is a comparative study conducted in NIT, Faridabad. The purposive sampling was done to select 8 male adults (18-30) years, athletes. Anthropometric measurement and biochemical measurements were measured by using standardized process. Blood pressure and heart rates were measured by electric BP machine. The results revealed that after three hours of dehydrating exercise test, a physical performance test was conducted by using treadmill. Regarding treadmill performance, mean and standard deviation of total exercise time in Plain water was 43.62±5.92, coconut water 44.00±5.65, carbohydrate electrolyte sports drink 43.75±5.70, and sodium enriched olive coconut drink was 44.25±5.35 but the difference was not statistically significant. The study concluded that the sodium enriched coconut drink has a better effect on the performance as compared to other drinks but differences were not so, more sample can be included to have better results.

Keywords: Coconut, Olives, Rehydration, Sodium.

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I. Introduction

Coconut water is naturally occurring and is very rich in potassium, contain sodium chloride and carbohydrate, coconut water may be used as oral rehydration aid to replace fluid loss. Coconut water has reported to provide hydrating effects similar to those of carbohydrate – electrolyte sport drink. It also has an antioxidant property. Sports drink is ubiquitous within the recreational and competitive fitness and sporting world. Most manufactured and artificially flavored carbohydrate –electrolyte sport beverage⁽¹⁾. The antioxidant ability of coconut water was recently studied by a few authors, reflect. The increasing interest in the nutraceutical properties of natural products.⁽²⁾ Recently, attention has been given to coconut water, a natural attentive to manufactured sports drink, within initial evidence indicating efficacy with regard to maintaining hydration. The amount of carbohydrate in a drink will depend on circumstances. High carbohydrate concentrations will delay gastric emptying, thus reducing the amount of fluid that is available for absorption very high concentrations will result in secretion of water into the intestine and thus actually increase the danger of dehydration. However, where there is a need to supply an energy source during exercise, increasing the carbohydrate content of drinks will increase the delivery of carbohydrate to the site of absorption in the small intestine. As carbohydrate concentration increases, the volume of fluid emptied from the stomach is reduced but the amount of carbohydrate available for absorption is increased⁽³⁾. Rehydration after exercise not only replacement of volume loss but also replacement of electrolyte primarily lost of sodium loss in sweat. Such sodium loss can result in complete rehydration and many predispose the athlete to heat cramp during subsequent exercise⁽⁴⁾. Rapid and complete restoration of fluid balance after exercise is an important part of the recovery process. Heavy sweating during exercise can cause body fluid losses in excess of 1 liter per hour. Individual must ingest sufficient fluid to recover from their dehydrated state. Rehydration after exercise not only replacement of volume loss but also replacement of electrolyte primarily lost of sodium loss in sweat. Such sodium loss can result in complete rehydration and many predispose the athlete to heat cramp during subsequent exercise⁽⁵⁾.

II. Methodology

The present study was conducted to compare water, coconut water and carbohydrate electrolyte sports drink on measures of hydration and physical performance of athletes. The study was conducted in NIT Faridabad, Haryana, and North India. Purposive sampling was done to select 8 adult (18 – 30 years) athlete subjects of endurance sport to conduct the present study. Inclusion criteria was, subject engaged in a program of regular exercise for a minimum of past six months, no difficulty in walking and running, do not use any new supplements, males were included in the study and subject willing to participate in the study. Exclusion criteria was - females were excluded, those who were not willing to participate, Smokers, Reported the history of cardiovascular, metabolic, neurological, orthopedic disorder, use of any new nutritional supplements. The standardized questionnaire entitled as Physical Activity Readiness Questionnaire [PARQ], was used to collect health history. Anthropometric measurements were done by using standardized tools, which include weight via digital scale. The biochemical measurements were measured by standardized process. The biochemical parameters include Urine gravity Blood Pressure and head rate was measured by electric BP machine. The study was divided into 3 phases:

- 1) Dehydration phase
- 2) Hydration phase
- 3) Physical performance test

DEHYDRATION PHASE

The dehydrating exercise consisted of two stages - 30-minute bouts of walking/jogging, interspersed with a 10 minute rest period. Specifically, subjects walked/jogged at 2, 3, 4, 5, 6 and 7 miles per hour on a motorized treadmill, using a grade of 0%. Five minutes of exercise was performed at each speed. Following the initial 30 minutes of exercise, a 10-minute break was allowed, during which time subjects walked around and/or remained seated. Subjects then repeated the above sequence of speeds for an additional 30 minutes of exercise. Hence, a total of 60 minutes of exercise was performed within the 70 minute period.

HYDRATION PHASE

Subjects received their assigned condition (beverage), cross-over assignment to one of the following four conditions - plain water, coconut water coconut water, carbohydrate-electrolyte sport drink and sodium enriched coconut drink. The amount of each beverage was determined based on the total amount of body mass lost during the dehydrating exercise protocol using the equation: $1300 \text{ mL} \cdot \text{kg}^{-1} \times \text{kg loss} = \text{amount of beverage consumed (mL)}$. Subjects were allowed 60 minutes to consume the entire volume of beverage. Each condition was consumed on a different test day, with a minimum of five days separating test visits.

EXERCISE PERFORMANCE PHASE

Three hours after the completion of the dehydrating exercise test (and two hours after subjects consumed their assigned condition), a test of physical performance was conducted using a treadmill as previously done. Specifically, subjects began walking on a motorized treadmill at a self-selected comfortable speed (0% grade) for five minutes. At the conclusion of the five-minute period, the actual performance test began. The protocol involved an increase in intensity every three minutes. While the speed of the treadmill remained constant at 4.2 miles per hour throughout the test, the grade increase in the following manner: min 1-3, 0%; min 4-6, 2.5%; min 7-9, 5%; min 10-12, 7.5%; min 13-15, 10%; min 16-18, 12.5%; min 19-21, 15%. Subjects exercised until volitional exhaustion and the total exercise time was recorded.

III. Result And Discussion

Experimental Analysis

Table 1. Body mass of athletes before and after dehydrating exercise

STAGES	PLAIN WATER	COCONUT WATER	CARBOHYDRATE ELECTROLYTE SPORTS DRINK	SODIUM ENRICHED COCONUT DRINK	P-value (ANOVA)
Pre-dehydrating exercise performance test	60.9±6.24	60.97±6.24	60.9±6.24	60.9±6.24	0.00
Immediately post dehydrating test	59.6±6.3	59.4±6.2	59.6±6.3	59.6±6.3	
1 hour post dehydrating test	62.1±6.61	62.13±6.57	62.1±6.61	62.1±6.61	
2 hour post dehydrating test	61.9±0.0	62.41±7.2	61.9±0.0	61.9±0.0	
3 hour post dehydrating test	61.2±6.64	61.64±0.0	61.2±6.64	61.2±6.64	

Table no. 1 described the body weight of target subjects. There were four stages in which - plain water, coconut water, carbohydrate electrolyte drink and sodium enriched coconut drink was given to the subjects. During each experimental day, the Body Weight was measured in 5 stages - pre-dehydrating exercise test,

immediately post dehydrating test, one hours post dehydrating test, Two hours post dehydrating test and Three hours post dehydrating test.

During 1st experimental day of 1st week, the mean and standard deviation of body weight of the target group during pre dehydrating phase was 60.9±6.24. After dehydration treadmill test the mean and standard deviation of body mass was reduced by 59.6±6.3. After 1st hour post dehydrating exercise test the mean and standard deviation of body mass was raised by 62.1± 6.61 because of rehydration fluid (PLAIN WATER) given just after treadmill test. In 2nd hour of dehydrating exercise test the mean and standard was 62.41±7.2. In 3rd hour of post dehydrating test the mean and standard deviation was 61.64±6.64.

During the 2nd experimental day of 2nd week, the pre dehydrating exercise test, the mean and standard deviation of body mass was 60.97±0.0. Immediately after exercise the mean and standard deviation was 60.9±6.24 it shows that the subject's body mass was decreased. In 1st hour of post dehydrating exercise test, the mean and standard deviation was 62.13±6.57 because of rehydration fluid (COCONUT WATER) given just after treadmill test. In 2nd hour of dehydrating exercise test the mean and standard was 62.41±7.2. In 3rd hour of post dehydrating test the mean and standard deviation was 61.64±6.64.

During 3rd experimental day of 3rd week, the pre dehydrating exercise test, the mean and standard deviation of body mass was 60.97±0.0. Immediately after exercise the mean and standard deviation was 60.9±6.24 it shows that the subject's body mass was decreased. In 1st hour of post dehydrating exercise test, the mean and standard deviation was 62.13±6.57 because of rehydration fluid (CARBOHYDRATE ELECTROLYTE DRINK) given just after treadmill test. In 2nd hour of dehydrating exercise test the mean and standard was 61.9±7.2. In 3rd hour of post dehydrating test the mean and standard deviation was 61.64±6.64.

During 4th experiment of 4th week, the pre dehydrating exercise test, the mean and standard deviation of body mass was 60.97±0.0. Immediately after exercise the mean and standard deviation was 60.9±6.24 it shows that the subject's body mass was decreased. In 1st hour of post dehydrating exercise test, the mean and standard deviation was 62.13±6.57 because of rehydration fluid(SODIUM ENRICHED COCONUT DRINK) given just after treadmill test. In 2nd hour of dehydrating exercise test the mean and standard was 61.9±7.2. In 3rd hour of post dehydrating test the mean and standard deviation was 61.64±6.64.

A study has done by **kalman et al. (2012)** stated the similar result, no differences was noted, In regard to body mass, subjects lost approximately 1.7 kg during the dehydrating exercise (~2% of starting body mass), regained this amount in a similar manner following consumption of all conditions, and slowly lost approximately 1 kg over the subsequent two hours. However, body mass (p = 0.023) was slightly greater with coconut water from concentrate compared b only to bottled water (when expressed as change from pre dehydrating exercise at 3 hours post dehydrating exercise). No other differences were noted between conditions for body mass (p > 0.05).

Table 2. Urine Specific Gravity of athletes before and after dehydrating exercise

Stages	Plain water	Coconut water	Carbohydrate electrolyte sports drink	Sodium enriched coconut drink	P-value (ANOVA)
Pre-dehydrating exercise	1.02±0.0	1.02±0.0	1.03±0.00	1.02±0.005	0.00
Immediately post dehydrating exercise	1.03±0.00	1.03±0.00	1.03±0.00	1.01±0.00	
3hour post dehydrating exercise	0.35±0.00	0.35±0.00	1.01±0.008	1.01±0.005	

The above table 2 described the urine specific gravity of the subjects.

Normal Urine Specific Gravity can range from 1.003 to 1.020, a value of less than 1.010 indicates relative hydration, and a value greater than 1.020 indicates relative dehydration. In the present study, there were four stages in which plain water, coconut water and carbohydrate electrolyte drink and sodium enriched coconut drink was given to the subjects. During each experiment day, the urine specific gravity was measured in 3 stages - pre-dehydrating exercise test, post dehydrating test, three hours post dehydrating test.

During the 1st experimental day of 1st week, the urine specific gravity was 1.020±0.0 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the urine specific gravity was increased by 1.030±0.0. This indicates that the subjects were dehydrated. In third stage, after three hours post dehydrating test (after 3 hours of rehydration with plain water), the urine specific gravity was decreased by 1.020±0.0.

During the 2nd experimental day of 2nd week, the urine specific gravity was 1.020±0.0 at pre dehydrating exercise test stage. In second stage, immediately post dehydrating test, the urine specific gravity was increased by 1.030±0.0 this indicates that subject was dehydrated. In third stage, after three hours post dehydrating test (after 3 hours of rehydration with coconut water), the urine specific was decreased by 1.030±0.0.

During 3rd experimental day of 3rd week, the urine specific gravity was 1.020±0.0 at pre dehydrating exercise test stage, In second stage, the immediately post dehydrating exercise test, the urine specific gravity was increased by 1.030±0.0 this indicates that the subject was dehydrated. In third stage, after three hour post dehydrating exercise test(after 3 hours of rehydration with carbohydrate electrolyte sports drink), the urine specific gravity was decreased by 1.01±1.008.

During 4th experimental day of week 4th the urine specific gravity was 1.020±0.0 at pre dehydrating exercise test. In second stage, after immediately post dehydrating exercise test, the urine specific gravity was increased by 1.030±0.0 this indicates that the subjects was dehydrated. In second stage, three hours post dehydrating exercise test (after 3 hours of rehydration with sodium enriched coconut drink),, the urine specific gravity was decreased by 1.010±1.005.

A study has done by **kalman et al. (2012)** stated the similar result, no differences were noted between conditions for urine specific gravity, with this measure relatively constant and within the normal range over the measurement period (p > 0.05).

Table 3. Heart Rate of athletes before and after dehydrating exercise

STAGES	PLAIN WATER	COCONUT WATER	CARBOHYDRATE ELECTROLYTE SPORTS DRINK	SODIUM ENRICHED COCONUT DRINK	P-value (ANOVA)
Pre dehydrating exercise test	67.62±6.13	66.87 ± 6.05	67.62 ± 6.13	67.6 ± 6.13	0.00
Immediately post dehydrating exercise test	104.5 ± 9.79	109.87 ± 9.53	104.5 ± 9.79	104.5 ± 9.7	
3hour post dehydrating exercise test	72.37 ± 10.51	72.37 ± 10.51	72.3 ± 10.51	72.37 ± 10.51	
Immediately post performance exercise test	100.72±8.82	99.50±9.01	102.72±9.23	100.72±8.23	

Table no. 3 depicted the heart rate of athletes before and after dehydrating exercise. There were four stages in which - plain water, coconut water, carbohydrate electrolyte drink and sodium enriched coconut drink was given to the subjects. During each experimental day, the heart rate was measured in 4 stages - pre-dehydrating exercise test, immediately post dehydrating test, three hours post dehydrating test and immediately post performance test.

During the 1st experimental day of 1st week, the heart rate was 67.62±6.13 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the heart rate was increased by 104.5±9.79. In third stage, after three hours post dehydrating test (after 3 hours of rehydration with plain water), the heart rate was 72.37 ± 10.51. In 4th stage, immediately post performance exercise test the heart rate was 100.72±8.82

During the 2nd experimental day of 2nd week, the heart rate was 67.62±6.13 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the heart rate was increased by 109.5±9.53. In third stage, after three hours post dehydrating test (after 3 hours of rehydration with coconut water), the heart rate was 72.37 ± 10.51. In 4th stage, immediately post performance exercise test the heart rate was 99.50±9.01

During the 3rd experimental day of 3rd week, the heart rate was 67.62 ± 6.13 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the heart rate was increased by 104.5 ± 9.79. In third stage, after three hours post dehydrating test (after 3 hours of rehydration with carbohydrate electrolyte sports drink), the heart rate was 72.3 ± 10.51. In 4th stage, immediately post performance exercise test the heart rate was 102.72±8.23.

During the 4th experimental day of 4th week, the heart rate was 67.6 ± 6.13 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the heart rate was increased by 104.5 ± 9.7. In third stage, after three hours post dehydrating test (after 3 hours of rehydration with sodium enriched coconut drink), the heart rate was 72.37 ± 10.51. In 4th stage, immediately post performance exercise test the heart rate was 100.72±8.23. A study has done by **kalman et al. (2012)** stated the similar result, no differences were noted between conditions for heart rate, (p > 0.05).

Table 4. Systolic Blood Pressure of athletes before and after dehydrating exercise

STAGES	PLAIN	COCONUT	CARBOHYDRATE	SODIUM	P-value
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	WATER	WATER	ELECTROLYTE SPORTS DRINK	ENRICHED COCONUT DRINK	(ANOVA)
Pre-dehydrating exercise test	117.0± 3.80	116.25± 3.80	117.3± 2.55	115.25± 3.84	0.00
Immediately post dehydrating exercise test	140.75± 7.16	141.10 ±7.10	140.12± 6.49	140.75± 5.33	
3 hour post dehydrating test	114.5± 6.41	117.25± 9.16	114.87± 2.69	121.75± 5.33	
Immediately post performance exercise test	136.5 ±8.75	117.25± 9.16	139.12 ±4.48	137.5± 6.80	

Table no. 4 depicted the Systolic Blood Pressure of athletes before and after dehydrating exercise. There was three stages in which – plain water, coconut water and carbohydrate electrolyte drink and sodium enriched coconut drink were given to the subjects. During each experimental day, the systolic was measured in 4 stages - pre-dehydrating exercise test, post dehydrating test, three hours post dehydrating test.

During the 1st experimental day of 1st week, the systolic blood pressure was 117.0± 3.80 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the systolic pressure was increased by 140.75± 7.16. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with plain water), the systolic pressure was maintained by 114.5±6.41. Immediately post performance exercise test the systolic pressure was increased by 136.5±8.75

During the 2nd experimental day of 2nd week, the systolic was 116.25± 3.80 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the systolic pressure was increased by 141.10 ±7.10. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with coconut water), the systolic pressure was maintained by 117.25± 9.16, in normal range. Immediately post performance exercise test the systolic pressure was increased by 138.25±7.9

During the 3rd experimental day of 3rd week, the systolic pressure was 115.25± 3.84 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the systolic pressure was increased by 140.75± 5.33. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with coconut water), the systolic pressure was maintained by 117.25± 9.16. Immediately post performance exercise test the systolic pressure was increased by 140.12± 6.49

During the 4th experimental day of 4th week, the systolic was 115.25± 3.84 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the systolic pressure was increased by 141.10 ±7.10. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with coconut water), the systolic pressure was maintained by 121.75± 5.33. Immediately post performance exercise test the systolic pressure was increased by 137.5± 6.80 A study has done by **kalman et al. (2012)** stated the similar result; no differences were noted between conditions for systolic blood pressure (P > 0.05).

Table 5. Diastolic Blood Pressure of athletes before and after dehydrating exercise

STAGES	PLAIN WATER	COCONUT WATER	CARBOHYDRATE ELECTROLYTE SPORTS DRINK	SODIUM ENRICHED COCONUT DRINK	P-value (ANOVA)
Pre-dehydrating exercise test	70.0± 3.89	79.25± 9.49	83.25± 9.09	69.00± 2.32	0.00
Immediately post dehydrating exercise test	87.87 ±12.01	96.12 ±8.91	94.62± 4.20	86.00± 7.21	
3 hour post dehydrating test	81.62 ±12.4	72.87± 6.22	74.12± 9.35	81.62± 12.4	
Immediately post performance exercise test	84.25± 13.93	84.25± 13.93	87.00± 10.44	84.25± 13.9	

Table no.1.5 depicted the Diastolic Blood Pressure of athletes before and after dehydrating exercise. There was four stages in which - plain water, coconut water and carbohydrate electrolyte drink and sodium enriched coconut drink were given to the subjects. During each experiment day, the diastolic pressure was measured in 4 stages - pre-dehydrating exercise test, post dehydrating test, three hours post dehydrating test.

During the 1st experimental day of 1st week, the systolic pressure was 70.0±3.89 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the diastolic pressure was increased by 87.7±12.01. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with plain water), the diastolic pressure was maintained by 81.62±12.4. Immediately post performance exercise test the diastolic pressure was increased by 84.25±13.93

During the 2nd experimental day of 2nd week, the diastolic pressure was 79.25±4.94 at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the diastolic pressure was increased by 96.12 ± 8.91. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with coconut water), the diastolic pressure was maintained by 72.87± 6.22. Immediately post performance exercise test the diastolic pressure was increased by 84.25± 13.93

During the 3rd experimental day of 3rd week, the diastolic pressure was 83.25 ±9.09at pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the diastolic pressure was increased by94.62± 4.20. In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with coconut water), the diastolic pressure was maintained 74.12±9.35. Immediately post performance exercise test the diastolic pressure was increased by 87.00±10.44.

During the 4th experimental day of 4th week, the systolic was 69.00 ± 2.32pre-dehydrating exercise test stage. In second stage, immediately post dehydrating test, the systolic pressure was increased by 86.00 ± 7.21 In third stage, after 3 hours post dehydrating test (after 3 hours of rehydration with coconut water), the systolic pressure was maintained by 81.62 ± 12.4. Immediately post performance exercise test the systolic pressure was increased by 84.25 ± 13.9 A study has done by **kalman et al. (2012)** stated the similar result; no differences were noted between conditions for diastolic blood pressure, (p > 0.05).

Table 6. Total Time of athletes immediately after performance test

Stages	Performance test	P-value (ANOVA)
Plain water	43.62±5.92	0.996
Coconut water	44.00±5.65	
Carbohydrate electrolyte sports drink	43.75±5.70	
Sodium enriched coconut drink	44.25±5.35	

Table no. 6 depicted total time immediately after performance test. After three hours of dehydrating exercise test, a physical performance test was conducted by using treadmill. Regarding treadmill performance, mean and standard deviation of total exercise time in Plain water 43.62±5.92, coconut water 44.00±5.65, carbohydrate electrolyte sports drink 43.75±5.70, sodium enriched coconut drink 44.25±5.35 but the difference was not statistically significant.

IV. Conclusion

The study concluded that the sodium enriched coconut drink had a better effect on the performance test as compared to other drinks but differences were not statistically significant so, more sample size can be included to have better results. The limitation of the study might be that the intervention of coconut water was done only once, one time during exercise.

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