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# Formulation and quality evaluation of fruit and vegetable-based energy drink

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## Abstract

Among specific food products, sports drinks, as well as energy drinks, have become very popular in the last few decades. Although energy drinks currently available are particularly rich with stimulants like caffeine those are very important to the people like athletes, students, and elderly people. The long-term exposure to various components of energy beverages may cause adverse health effects. The present study aims to develop a nutritionally rich natural energy drink formulation using locally available fruits and vegetables without adding stimulants like caffeine. Different combination of energy drink formulations were prepared using different combinations of beetroot, watermelon, pomegranate, orange juices, and king coconut water. Different combinations of energy drink formulations were evaluated based on physicochemical properties, energy content, and organoleptic properties. The best performing formulation was treated with Sodium metabisulphite (SMS) and Sodium Benzoate (SB) with a control (no added preservative) and stored under room temperature (30ºC) vs. the refrigerated condition (4±2ºC). Data obtained in triplicate (n=3) and the results were analyzed by completely randomized using ANOVA. Mean separation was done using Least Significant Difference (LSD) at $\alpha = 0.05$. The selected best formula contained beetroot (40%), watermelon (20%), pomegranate (30%) and orange (5%) juices, and king coconut water (5%) by volume with 50 ppm of sodium benzoate as a preservative. The content of energy is 54.74 $kcal.g^{-1}$ and 12.37 g of carbohydrate per 100 mL of beverage. Therefore the product can be stored at refrigerated conditions (4±2ºC) for a period of two months without deteriorating the quality.

**Keywords**

Energy drink, Fruits, Nutrition, Storage, Vegetables

## Introduction

Energy drinks have been promoted as a healthy beverage within many sub populations, such as, athletes and students, etc. The high concentration of ingredients in the drink that stimulate the body and mind is the cause of many complications. The performance of most of these energy drinks should be monitored because of the unbalanced ingredients, especially sugar and caffeine in their compositions. There are healthier alternative energy drinks that contain significantly lower, sugars, and calories. It is important to consume natural sugars found in fruits, vegetables while avoiding added sugars. Energy drinks are non-alcoholic beverages and most of the synthetic functional beverages contain caffeine as the main active ingredient (Aranda et al., 2006). Now energy drinks are available in more than 140 countries. Most of the consumers of these drinks are children, adolescents, and young adults (Seifert, 2011). Sri Lanka produces about 602,000 metric tons of vegetables and 855,000 metric tons of fruits annually. This comprises of over 40 vegetables and 50 fruit varieties grown in different agro-climatic regions. It is estimated that 30% - 40% of all fruits and vegetables are wasted between harvest and marketing due to poor post-harvest handling. The increased recognition of fruits and vegetables as important components of a healthy diet has undoubtedly benefitted the industry of the same. The overall trend in new fruit and vegetable products is "added value", thus, providing increased convenience to the consumer by having a much greater variety of readily prepared fruit and vegetable products. In this paper, the energy drink developed comprising of the following major constituents: Beetroot (*Beta vulgaris*), Watermelon (*Citrullus lanatus*), Pomegranate (*Punica granatum*), Orange (*Citrus centifolia*), King Coconut water (KCW) (*Cocos nucifera*).

## Methodology

### Formulation of energy drink

The experiment was carried out at the National Institute of Postharvest Management, Research and Development Center, Anuradhapura, Sri Lanka. Fruits were obtained from local markets which were superior in quality without significant sign of quality deteriorations. Here, the energy drink was developed as compose of the following major constituents: Beetroot (*Beta vulgaris*), Watermelon *(Citrullus anatus*), Pomegranate *(Punica granatum),* Orange (*Citrus crenatifolia),* King Coconut water (*Cocos nucifera*) (Table 1).

### Sample preparation

The fruits were washed and disinfected by immersing 50 ppm sodium hypochlorite for 15 min. The juice was extracted using juice extractor Fengxiang®, FC-310: China. Raw juices were clarified by bentonite using concentrations of 3 $gL^{-1}$. The juice was centrifuged at 6000 rpm in a HERMLE centrifugation unit (model Z326k) for 20 minutes at 4 °C temperature. The Juice blend was pasteurized 96 °C 15 min. The hot filling was done using pre-sterilized bottles by maintaining the headspace about 1 inch and capping was done using a manually operated bottle sealing machine. (Palet 3.2 Manual cap Sealing machine). Bottles were kept in the refrigerator (4 ±2 °C) and room temperature (30 °C) separately. The better performing treatment was selected based on physico chemical, organoleptic properties, and energy content of the prepared juice blends.

***Table 1.*** *Composition of the energy drinks formulations*

| Treatment | Beetroot Juice | Watermelon Juice | Pomegranate Juice | Orange Juice | KCW |
|---|---|---|---|---|---|
| Treatment 01 | 40 | 20 | 30 | 5 | 5 |
| Treatment 02 | 40 | 30 | 20 | 5 | 5 |
| Treatment 03 | 40 | 40 | 10 | 5 | 5 |

Two different chemical preservatives such as Sodium Metabisulphite (SMS), Sodium benzoate (SB) were used to enhance the keeping quality of juice blends and another sample was kept as a control without adding any chemical preservatives. The treatments were stored under room temperature (30°C) and refrigerator condition (4 ±2°C) for 8 weeks. The physicochemical properties, microbiological quality, and sensory evaluation were done once in the two-week interval.

### Measurement of total soluble solids (TSS), colour, pH and titratable acidity, proximate composition, organoleptic properties, and energy calculation

TSS of the extracted juice was measured by a temperature-compensated digital refractometer (3,810. Atago PAL-1) and is expressed as a percentage. TA was determined as per AOAC (2000). Juice pH was measured by a pH meter (230A+, Thermoorin). Product colour was measured by using Hunter lab color difference meter (CR 400, Konica Minolta) and the values of L*, a*, b* were recorded. The total plate count and yeast and mold count were done as described in AOAC (2000). A proximate composition such as moisture, fat, crude fiber, crude protein, and ash content were determined using the method described in AOAC (2000). The energy value of energy drink formulations was calculated based on their content of crude protein, fat, and carbohydrate using the formula described by Crisan and Sands (1978). Three different formulations (Table. 01) were subjected to evaluate the sensory properties such as external appearance, internal appearance, colour, aroma, taste, texture, and overall acceptability by 30 semi-trained panelists using 5 point Hedonic scale. Different energy drink formulations were stored at two different temperatures such as ambient (30 °C, RH 70%) and refrigerated storage (4 °C± 2 °C).

### Experimental design and analysis

Data obtained were in triplicate (n=3) and the results were assessed by completely randomized design using ANOVA by SAS statistical package. Mean separation was done by using Least Significant Difference (LSD) at α= 0.05.

## Results and Discussion

***Table 2.*** *Effect of different juice combinations on changes in chemical properties of energy drink formulations*

| Treatment | TSS | TA | pH |
|---|---|---|---|
| Product 01 | 10.03 ± 0.15 | 0.25 ± 0.00 | 4.06 ± 0.04 |
| Product 02 | 9.73 ± 0.05 | 0.25 ± 0.00 | 4.08 ± 0.05 |
| Product 03 | 9.50 ± 0.00 | 0.27 ± 0.03 | 4.34 ± 0.01 |

Product 1 recorded the highest TSS content compared with other treatments and there was no any significant different (α= 0.05) in TA and pH between treatment 2 and 3. Treatment 3 was significantly different from other two treatments (Table 2).

***Table 3.*** *Effect of different juice combinations on proximate composition of energy drink formulations*

| Proximate composition | Product 01 | Product 02 | Product 03 |
|---|---|---|---|
| Moisture content | 86.30 ± 0.30 | 86.67 ± 0.01 | 87.20 ± 0.00 |
| Crude Fat (Ether extract) | 0.18 ± 0.01 | 0.17 ± 0.00 | 0.16 ± 0.01 |
| Crude fiber | 0.17 ± 0.01 | 0.21 ± 0.01 | 0.24 ± 0.01 |
| Ash | 0.07 ± 0.01 | 0.070 ± 0.00 | 0.06 ± 0.01 |
| Protein | 0.88 ± 0.00 | 0.90 ± 0.02 | 0.98 ± 0.00 |
| Carbohydrate | 12.37± 0.01 | 11.96± 0.02 | 11.35± 0.01 |

***Table 4.*** *Calorific values of the energy drink formulations*

| Treatments | Energy ($kcalg^{-1}$) | Energy ($kJg^{-1}$) |
|---|---|---|
| Product 1 | (12.37 * 4) + (0.88*4) + (0.186*9)<br>= 54.74 | (12.37* 17) + (0.88*17) + (0.18*37)<br>= 232.35 |
| Product 2 | (11.96*4) + (0.90*4) + (0.17*9)<br>= 53.70 | (11.96*17) + (0.90*17) + (0.17*37)<br>= 220.75 |
| Product 3 | (11.35 *4) + (0.98*4) + (0.16*9)<br>= 50.78 | (11.35 *17) + (0.98*17) + (0.16*37)<br>= 215.61 |

Table 4 recorded that, the highest energy value was recorded by the product one when compare to other treatments.

**Sensory analysis**

Figure 1 illustrated that, 20% watermelon incorporated energy drink gave the highest estimated median 8.6, 8, 8.6, 8.6 were recorded for appearance, colour, taste and aroma respectively. Therefore the overall acceptability of 20% watermelon incorporated energy drink were recorded the highest estimated median (8.5) and highest sum of rank (76) by accepting as a better formulation for storage.

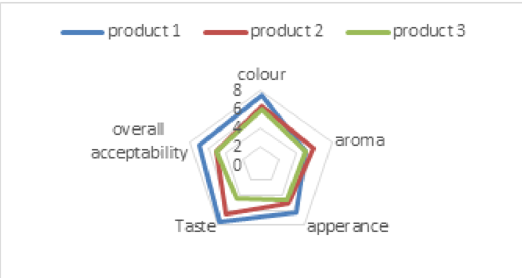


***Figure 1.*** *Effect of different concentration of fruit juices on organoleptic properties of energy drink*

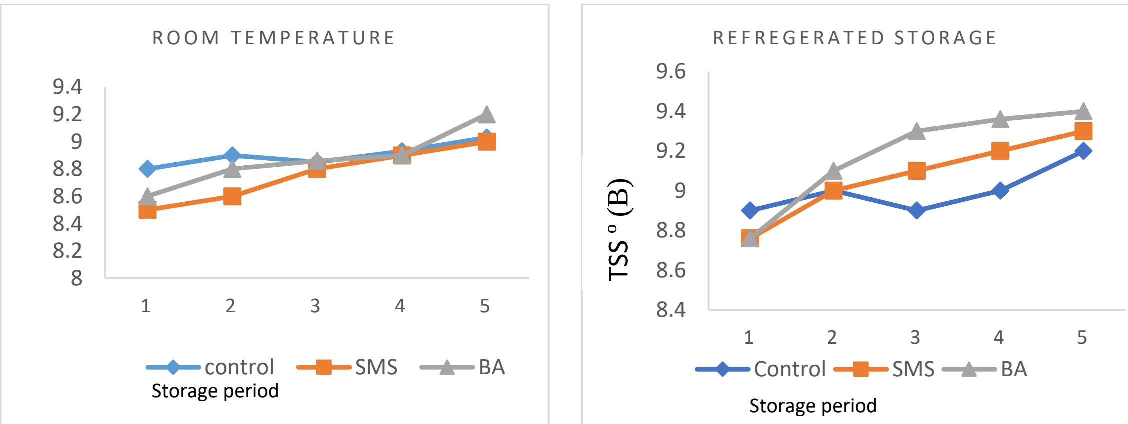


***Figure 2.*** *Effect of SMS and Sodium Benzoate application on TSS of energy drink under room temperature and the refrigerated storage*

The results in figure 2 showed that total soluble solid content in beverage was increased during the storage period which is preserved using two different chemical preservatives (SMS and SB) and control. Total soluble content was gradually increased with the storage period probably due to the conversion of polysaccharides into sugars in the presence of organic acids. Tandon et al. (2003) also reported no significant changes in the total soluble solids during storage. Bull et al. (2004) reported that the °Brix of thermally processed orange juice did not change significantly during storage time.

The figure 3 and 4 shows the changes of pH and titratable acidity respectively in products treated with SMS, SB, and control sample at room temperature. pH values of energy drinks were gradually decreased up to the 8th week. Chemical degradation and chemical reactions may be the possible reasons for these changes. The changes of acidity of three treatments at refrigerator condition were exhibited the gradually increased due to decrease of pH. This Increasing trend was earlier observed by Chauhan et.al 2012. pH decreased and acidity increased due to the degradation of carbohydrates in fruit juices (Ahmad et.al 2011). Brix, pH, and Acidity are three parameters extremely important as they decide the quality of RTS beverages (Patil et. al. 2009). The results compromise with Bull et al. (2004) who studied the thermally processed Valencia and Navel orange juice found no significant modifications of total titratable acidity throughout the storage time

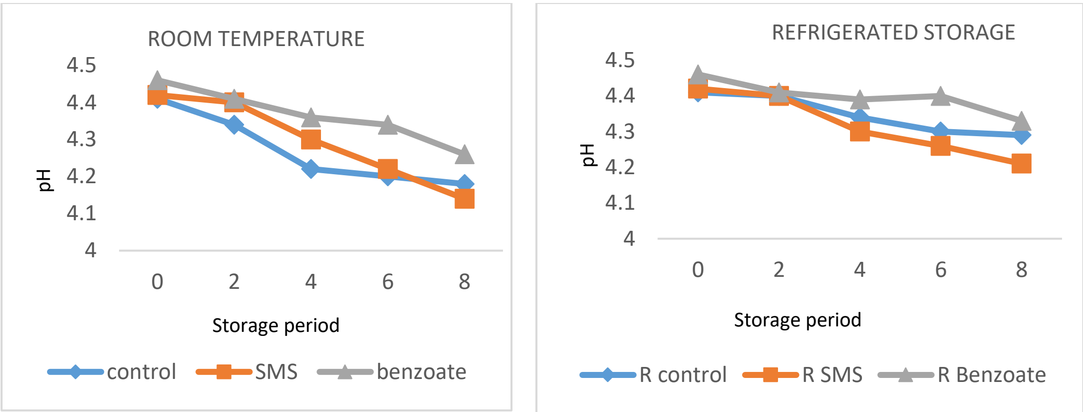


***Figure 3.*** *Effect of SMS and Sodium Benzoate application on pH of energy drink under room temperature and the refrigerated storage*

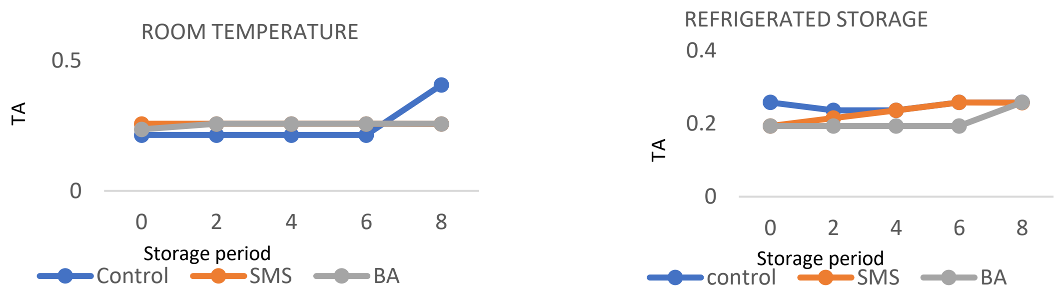


***Figure 4.*** *Effect of SMS and Sodium Benzoate application on TA of energy drink under room temperature and the refrigerated storage*

Total plate counts (TPC) values were recorded in beverages during the storage of eight weeks. The total plate counts were increased in the products at both storage conditions and the high microbial count was observed in the control sample at room temperature, while preservative added refrigerated samples showed a comparatively low microbial count. Weakening of bacterial growth by lower pH due to addition of SMS and SB and bacterial death due to high temperature used in processing could be the reasons for this low growth of microorganisms in a prepared beverage (Nelugin, 2010). The findings were confirmed with the SLS (729:2010) that the total plate count for Ready serve fruit beverage should 50 per ml in maximum. No Yeast and mold count was observed during storage. Thermal pasteurization for a total heating time of 12 min was able to produce microbiologically stable fruit juices with the retention of quality attributes (Kathiravan et al., 2014).

Mapping of variation in colour of three different products at room temperature and refrigerated conditions condition showed that the minimum variations were observed in SB treatment whereas the variations were minimum at the refrigerated samples when compared to samples at room temperatures. According to Gokhale and Lele (2011) the yellow pigments of beetroot, betaxanthins, are more stable than the betacyanins (red pigments). Zhang et al. (1997) also found a color degradation in the heat pasteurized juice samples.

Based on the estimated median of colour, aroma, taste, appearance and overall acceptability refrigerated SB treated sample was the most preferred sample by the panelists.

## Conclusion

The selected formula contained beetroot (40%), watermelon (20%), pomegranate (30%) orange (5%) juices, and king coconut water (5%) by volume with 50 ppm of sodium benzoate as a preservative. It contained 54.74 kcal.$g^{-1}$ energy and 12.37 g of carbohydrate per 100 mL of beverage. The product was able to store at refrigerated conditions (4±2 ºC) for two month period without deteriorating the quality.

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