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Original Research Article

Development of Plant-Based Drink Using Cucumber, Carrots and Watermelon for the Management of Diabetes Patients and Other Parasitic Infections

Hassana M. K[1*], Fatima M. D[1], Egwuonwu K. C[2], Maryam S. I[1], Dahiru M. A[3]
[1]Department of Integrated Science, Federal College of Education Gidan Madi Sokoto State
[2]Department of Biology, Federal College of Education Gidan Madi Sokoto State
[3]Department of Chemistry, College of Basic and Remedial Sokoto

***Corresponding Author**
Hassana M. K
Department of Integrated Science, Federal College of Education Gidan Madi Sokoto State

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Abstract: Fresh Cucumber (*Cucumis sativus*), carrots (*Daucus carota*), and watermelon (*Citrullus lanatus*) were obtained from Sokoto Fish and Vegetable Market in Sokoto State, and all the chemicals/reagents used for the analysis were of analytical grade. The fresh vegetables were selected, cleaned, and juiced separately using a juice extractor. The juices were then filtered, pasteurized at 75 °C for 15 min and cooled. Thereafter, the juices extracts were divided into five varying proportions: A (100% carrot juice), B (80% carrot, 10% cucumber, 10% water melon), C (100% water melon), D (50% carrot, 25% cucumber, 25% water melon) and E (100% cucumber). The juice blends were then analyzed for phytochemical, proximate, mineral and vitamin compositions. The antioxidant properties were also determined. The proximate composition result revealed very high moisture (82.13% and 85.03%), relatively low carbohydrate (5.36–10.68%) and very low crude protein (1.85–4.90%) contents. For the micronutrients, potassium (14.80–32.20mg/100 mL) and vitamin C (14.58–24.50mg/100 mL) were more predominant when compared to the other micronutrients that were determined. While there were no statistically significant differences in the sensory properties of the juices, the 100% carrot juice was rated higher in all the attributes evaluated. It was concluded that a 50:50 blend of carrot and cucumber provided similar nutritional quality and superior antioxidative properties compared to other blends.

Keywords: Carrot Juice, Cucumber Juice, Juice Blends, Chemical Composition.

INTRODUCTION

Vegetables can originate from different parts of plants, including leaves, roots, or stems. These provide beneficial vitamins, minerals, fiber, and protein. Everyday vegetables like spinach, carrots, onions, tomatoes, cucumbers, and the like are excellent sources of these vital nutrients. The pigmentations found in vegetables also bestow upon them the capacity to provide additional advantages beyond the typical vitamins and minerals they are widely recognized for. For example, green, yellow, and orange-pigmented vegetables like cabbages, tomatoes, carrots, and cucumbers are abundant in beta carotene, which is a precursor to vitamin A.

Diabetes and parasitic infections are two significant public health concerns affecting millions of people worldwide. Diabetes, a chronic metabolic disorder characterized by high blood sugar levels, has been linked to various complications, including cardiovascular disease, kidney damage, and vision impairment. On the other hand, parasitic infections, caused by parasites such as Plasmodium, Toxoplasma, and Schistosoma, can lead to a range of health problems, including gastrointestinal issues, anemia, and even death.

Current treatments for diabetes and parasitic infections often involve pharmaceutical medications, which can have adverse side effects and contribute to the development of drug resistance. Therefore, there is a growing need for novel, effective, and safe therapies that can complement existing treatments.

Plant-based drinks have gained popularity in recent years due to their potential health benefits. Cucumber (Cucumis sativus), carrots (Daucus carota), and watermelon (Citrullus lanatus) are three plants that have been traditionally used for their medicinal properties. These plants are rich in antioxidants, fiber, and other nutrients that may help regulate blood sugar levels and exhibit anti-parasitic effects.

In recent years, there has been growing interest in plant-based diets for managing diabetes. Plant-based foods are naturally low in saturated fats, high in fiber, and rich in phytochemicals that have been shown to have various health benefits. Among these, certain vegetables like cucumber, carrots, and beetroot have garnered attention for their potential in blood sugar regulation (Sarkar *et al.,* 2017). The combination of these three vegetables into a single plant-based drink offers a promising dietary option for diabetes management. The proposed drink aims to harness the benefits of cucumber, carrots, and beetroot to provide a nutritious, low-glycemic beverage that can help regulate blood sugar levels while offering additional health benefits (Rizvi and Chillag, 2015).

This study aims to develop plant-based drinks using cucumber, carrots, and watermelon and evaluate their potential anti-diabetic and anti-parasitic effects. The findings of this study will contribute to the development of novel, plant-based therapies that can complement existing treatments for diabetes and parasitic infections.

Statement of the Problems/Justification

Despite advances in medical treatments, these conditions continue to pose a significant burden on individuals, communities, and healthcare systems. Diabetes is a chronic metabolic disorder characterized by high blood sugar levels, affecting over 460 million people worldwide (WHO, 2020). Current treatments for diabetes, such as insulin therapy and oral medications, can have adverse side effects and contribute to the development of drug resistance. There is a need for novel, effective, and safe therapies that can complement existing treatments for diabetes. Parasitic infections, caused by parasites such as Plasmodium, Toxoplasma, and Schistosoma, affect over 1 billion people worldwide (CDC, 2020).

Current treatments for parasitic infections, such as antiparasitic medications, can have adverse side effects and contribute to the development of drug resistance. There is a need for novel, effective, and safe therapies that can complement existing treatments for parasitic infections. Plant-based drinks have gained popularity in recent years due to their potential health benefits. Cucumber, carrots, and watermelon are three plants that have been traditionally used for their medicinal properties. These plants are rich in antioxidants, fiber, and other nutrients that may help regulate blood sugar levels and exhibit anti-parasitic effects. Despite the potential health benefits of cucumber, carrots, and watermelon, there is limited research on the development of plant-based drinks using these plants for the management of diabetes and parasitic infections.

Objectives of the Study

The broad objective of this research is to develop plant-based drinks using cucumber, carrots, and watermelon and evaluate their potential anti-diabetic and anti-parasitic effects.

The specific objectives were to;

i. Produce a palatable and nutritional plant-based drink using cucumber, carrots, and watermelon.
ii. Determine the proximate (nutritional) composition of the juice.
iii. Determine the mineral and vitamin composition of the juice.
iv. Determine the physicochemical properties of the juice.
v. Determine the sensory properties and quality acceptability of the mixed juice
vi. Investigate the anti-diabetic and anti-parasitic effects of the drinks.

MATERIALS AND METHODS

Materials

Fresh Cucumber (*Cucumis sativus*), carrots (*Daucus carota*), and watermelon (*Citrullus lanatus*) was obtained from Sokoto Fish and Vegetable Market in Sokoto State, and all the chemicals/reagents used for the analysis was of analytical grade.

Method of Preparation of Juice Samples

Fresh Cucumber (*Cucumis sativus*), carrots (*Daucus carota*), and watermelon (*Citrullus lanatus*) was selected, cleaned, and juiced separately using a juice extractor. The juice was then filtered, pasteurized at 75 °C for 15 min and cooled. Thereafter, the juices was divided into five varying proportions as shown in Table 1:

Table 1: Juice Mixing Ratio

Sample	Carrot	Cucumber	Watermelon
A	100	-	-
B	80	10	10
C	-	-	100
D	50	25	25
E	-	100	-

Analysis of the Smoothies

The proximate composition (ash, fat, moisture content, protein and carbohydrate) and other analyses such as percentage Brix, pH, viscosity and titratable acidity of the product was carried out using AOAC (2012).

Determination of Vitamin C Content

The vitamin C content was determined using ascorbic acid (0.01 mg/mL) as the reference compound. Two hundred milliliters of the extract was mixed with 300 mL of 13.3% trichloroacetic acid (TCA) and 75 mL of 2,4-dinitrophenylhydrazine (DNPH). The mixture was incubated at 37 °C for 3 h and 500 mL of H2SO4 was added to the mixture before the absorbance was read at 520 nm 9AOAC, 2012).

Determination of Vitamin A Content

An amount of 1 g of the sample was weighed, and then 30 mL of absolute alcohol and 3 mL of 5% potassium hydroxide was added to the sample. Next, the mixture was boiled gently at 50 °C under reflux (covered with cotton wool and wrapped with foil paper) for 30 min in a stream of oxygen-free nitrogen. It was rapidly cooled and washed with 3 × 50 mL of ether or petroleum ether and vitamin A was then extracted by shaking for 1 min. After complete separation, the lower layer was discarded and the extract was washed with 4 × 50 mL (3 × 10 mL) of water, mixing particularly cautiously during the first two washes to avoid emulsion formation. The washed extract was evaporated down to approximately 5 mL and the remaining ether was removed in a stream of nitrogen at room temperature. The residue was dissolved in sufficient isopropyl alcohol to give a solution containing 9–15 units per mL and the extinctions was measured at 300, 310, 325 and 334 nm with a wavelength of maximum absorption (Pearson and Cox, 1976).

Determination of Mineral Content

Five grams each of the carrot-cucumber juice samples was heated gently over a Bunsen burner flame until most of the organic matter was destroyed. The sample was further heated in a muffle furnace for several hours until white-grey ash was obtained. The ash material was cooled. About 20 mL of distilled water and 10 mL of the dilute hydrochloric acid was added to the ashed material. This mixture was boiled, filtered into a 250 mL volumetric flask, washed thoroughly with hot water, cooled and then made up to volume. The mineral content of the sample was analyzed using colorimetric or spectrophotometric or titrimetric methods where applicable (AOAC, 2012). The samples was analyzed for sodium (Na), potassium (K), calcium (Ca), iron (Fe) and magnesium (Mg).

Determination of Total Flavonoid Content

The total flavonoid content of the extract was determined using a colorimeter assay developed by Bao (2005) with some modifications. An aliquot (0.2 mL) of the extract was added to 0.3 mL of 5% NaNO2 and after 5 min, 0.6 mL of 10% AlCl3 was also added followed by the addition of 2 mL of 1 M NaOH, after 6 min, and 2.1 mL of distilled water. The absorbance was read at 510 nm against the blank reagent and the flavonoid content was expressed as mg rutin equivalent.

Determination of Total Phenolic Content

The total phenolic content of the extract was determined by the method of Nabavi *et al*., (2008) with some modifications. Two hundred microliters of the extract was mixed with 2.5 mL of 10% Folin–Ciocalteau's reagent and 2 mL of 7.5% sodium carbonate. The reaction mixture was subsequently incubated at 45 °C for 40 min and the absorbance was measured at 760 nm. Garlic acid was used as a standard phenol.

Determination of the Radical Scavenging

Ability (DPPH) The free radical scavenging ability of the extract against DPPH (1,1- diphenyl-2-picryhydrazyl) was carried out using the method of Nabavi *et al*., (2008) with slight modifications. One milliliter of the extract was mixed with 1 mL of the 0.4 mM methanolic solution of the DPPH, and then the mixture was left in the dark for 30 min before measuring the absorbance at 517 nm. The control consisted of methanol instead of the sample and the radical scavenging ability of the sample was calculated as:

$$\% DPPH = \frac{A_{control} - A_{sample}}{A_{control}} x\ 100$$

Determination of Ferric Reducing Antioxidant Power (FRAP)

The reducing property of the extract was determined by measuring 250 µL of the sample into test tubes (with distilled water as a blank), and 250 µL of 0.02 M phosphate buffer (pH 6.9) was added to it in addition to 250 µL of 1% $K3[Fe(CN)]6$. The mixture was incubated for 20 min at 50 °C. Thereafter, 250 µL of 10% TCA was added to the mixture, as well as 200 µL of 0.1% freshly prepared $FeCl3$ (Ferric Chloride) and 1 mL of distilled water. The absorbance was read at 760 nm. Ascorbic acid (0.01 mg/mL) was used as the standard.

Sensory Evaluation

The sensory evaluation of samples of the smoothie was carried out by 20 semi-trained panelists comprising of students within the premises of the FCE Gidan Madi, using a nine-point hedonic scale where the scores ranged from 'like extremely' (1) to 'dislike extremely' (9). Water was provided for each panelist for mouth rinsing after testing each product so as to avoid the carry-over effect.

Statistical Analysis

The sample measurements was performed in triplicate and the data was analyzed with SPSS version 17 (IBM, Armonk, NY, USA), while the means was separated for significant differences ($p < 0.05$) using Duncan's Multiple Range test.

3. RESULTS AND DISCUSSION

The results of the study are presented in Table 1-3. Proximate composition of the juice is presented in table 1 while the mineral and vitamin composition of the juice is presented in table 2. The physicochemical properties of the juice is presented in the fig 1 while the sensory properties of the juice is presented in table 3 below.

Table 1: Proximate composition of the juice (0%)

Samples	Crude Fibre	Moisture	Total Ash	Fat	Crude Protein	Carbohydrate
A	1.86	85.03	0.73	3.89	1.85	10.67
B	1.76	84.60	1.99	1.89	3.38	7.79
C	1.55	82.13	1.02	1.69	2.47	10.68
D	1.33	83.75	0.84	3.89	4.90	5.36
E	1.25	83.30	1.60	3.61	4.24	7.41

Table 2: Mineral elements and vitamin composition of carrot-cucumber juice (mg/100mL)

Samples	Calcium	Magnesium	Phosphorus	Potassium	Vit C.	VitA
A	3.30	1.20	4.93	32.20	14.58	5.38
B	2.25	0.14	4.82	31.15	21.17	2.72
C	1.47	0.17	4.82	26.52	24.50	2.83
D	1.81	0.18	3.50	21.46	17.81	1.91
E	1.70	1.50	2.51	14.80	15.64	2.83

Table 3: Sensory properties of the juice

Samples	Taste	Appearance	Aroma	Mouthfeel	Overall Acceptability
A	8.20	7.70	7.20	7.40	7.63
B	8.20	7.80	7.30	6.10	7.35
C	7.80	7.10	7.20	6.60	7.09
D	7.50	6.90	6.10	5.50	6.50
E	7.90	6.40	7.20	5.90	6.85

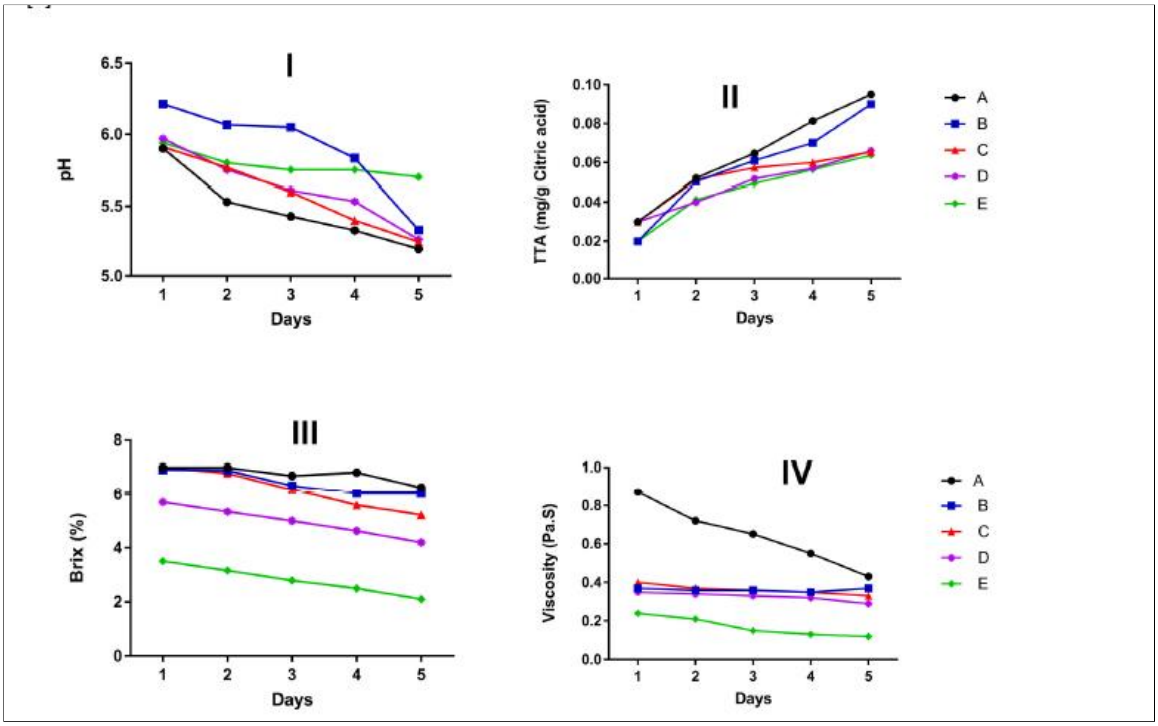

Fig. 1: The pH (I), total titratable acidity (TTA) (II), Brix (III) and viscosity (IV) of carrot cucumber and watermelon juice

3.1. Proximate Composition of the Juice

The proximate composition of carrot juice, cucumber juice and, watermelon juice is shown in table 2. Juices are known for their high moisture content which range between 82.13% and 85.03%, is expected because the raw materials, in particular cucumbers, from which the juice are made, are high in moisture content. The moisture content values obtained in this study are also relatively comparable to the range of 86.04-89.30% previously reported for carrot-yoghurt juice El-abasy *et al*., (2012) and also for other fruit juices as reported by Braide *et al.,* (2012). Although the crude protein content is generally low (1.85-4.90%), the proximate result also indicated that cucumbers contain significantly higher protein content (4.24%) when compared to carrots (1.85%). This difference mildly increased the protein content of the mixed beverages accordingly. A previous study on carrots also confirmed their low protein content (1.07%) (Olalude *et al.,* 2015). Although this is slightly lower than the value (1.85%) obtained in this study, the differences might be due to variations in the levels of maturity, variety and possibly geographical locations. While beverages are mostly cherished and consumed for their thirst-quenching abilities, varied reports also abound on the efforts being made to increase their nutritional quality, specifically, protein content and possibly, improved bioactivity, through the blending of two or more fruits or vegetables (Aderinola, 2018). The protein content obtained in this study (1.85 to 4.90) is higher in the proximate composition of the juice is its carbohydrate content, which ranged between 5.36 and 10.68%. The crude fiber obtained in this study (1.25-1.86%) is similar to the value (1.16) previously reported by Olalude *et al.,* (2015). The ash content, an inorganic aspect of foods, gives an indication of the range of mineral elements present in food materials (Aderinola, 2018). The total ash content of the juice sample ranged between 0.83 and 1.99%. The ash content obtained is higher than the ranges (0.38-0.58%) obtained by Dima *et al*., (2015).

3.2. The Mineral and Vitamin Composition of the Juice

The results of the mineral elements and vitamin compositions of the samples are shown in Table 2. Carrot Juice showed greater concentrations of all the minerals tested for the juice-calcium, magnesium, phosphorus and, Potassium-than cucumber juice. The concentration of potassium (14.80 - 32.20mg/100mL) is of particular significance when compared to the presence of other minerals in the products. Potassium is an essential constituent of cells and body fluids. It plays vital roles in controlling the heart rate and blood pressure (Dias, 2012). The ranges of the concentration of other minerals in the Vitamin C are a water soluble vitamin which also has antioxidant properties. The vitamin C content of the juice ranged between 14.58 and 24.50mg/100mL while vitamin A ranged between 1.91 and 5.38mg/100mL. The significantly higher vitamin A content of sample A (100% carrot juice) could be attributed to the higher bête carotene content in carrots.

3.3. Physicochemical Properties of the Juice

Figure 1-IV shows the physicochemical properties of the carrot-cucumber juice. The PH {Figure 1I} which ranged between 5.90 and 6.21 on the first day of production reduced to 5.20 and 5.70 after five days of storage. The gradual decline in pH towards acidity as the storage days progressed may be due to biochemical reactions taking place within the juice, particularly the fermentation process. This may be expected since the juices were only stored at refrigerated temperatures and no chemical preservative was used. The slight changes in the pH of sample E {100% cucumber juice} {5.94-5.70} compared to the pH of sample A {100% carrot juice} {5.91-5.20} may be due to the higher percentage of sugar in carrots as indicated by the percentage Brix value (Figure 1III), hence, a higher predisposition to fermentation. Therefore, in order to preserve the sensorial qualities of the juice, storage at freezing temperature may be explored or the length of storage at refrigerated temperature could be reduced. The reported pH of juices tends more towards an acidic pH range (Aderinola *et al.,* 2015), which may help in extending the shelf-life of the juice. This study also indicated that pH is indirectly related to total titratable acidity {TTA} {Figure 1II}. The TTA values of the juices ranged between 0.02 and 0.03mg/g on the first day of production to between 0.06 and 0.09 mg/g after five days of storage. Percentage Brix measures the soluble {sugar} content of juice.

As expected, Figure 1III shows that cucumbers contain less sugar content {3.51%} when compared to carrots {7%}. This is also reflected in the juice blends. Although there was no apparent significant differences between these samples {A, B and C} and sample D, which contained equal proportions of carrot and cucumber juice, and sample E {100% cucumber}, which was obviously due to lower sugar content in cucumbers. The 7% maximum Brix values obtained in this study for 100% watermelon and 100% orange juice, respectively (Aderinola *et al.,* 2015). Viscosity {Figure 1III} measures the ease of flow of the juices and it ranged between 024 and 0.87 Pa.s for the fresh samples to between 0.12 and 0.43 Pa.s after five days of storage. While there may be difference in the viscosity of the juices because of the type of raw material used, which may be influenced by the pulp content, the juices are generally liquids. The very low value of sample E may be expected, given the higher moisture content of cucumber compared to carrot. On the other hand, the higher sugar {Brix} content of the carrot juice might be responsible for the significantly higher viscosity of sample A. In addition, the gradual decline in the viscosity {sample A} may indicate liquefaction of the sugar due to fermentation. The obtained viscosity value for cucumber juice {0.12 Pa.s} is comparable to that reported for orange {0.1 Pa.s} and watermelon {0.2Pa.s} juices, respectively (Aderinola *et al.,* 2015).

3.4. Sensory Properties of Carrot-Cucumber Juice

Table 3 shows the evaluated results of the different sensory properties, namely, taste, appearance, aroma and, mouthfeel, for the juices. The overall acceptability was taken as the average of the four parameters {taste, appearance, aroma, and, mouthfeel}. The higher ratings for the taste, particularly in samples A and B {100 and 80% carrot content, respectively} may be due to the higher sugar content as revealed by the Brix content result {Figure 1III}. Obviously, the bright orange color, impacted by beta carotene in carrots, is more appealing than the chlorophyll green color of cucumbers and hence higher preference for the carrot juice. The color of the juice is impacted by the various colo producing phytochemicals, such as the carotenoids and chlorophyll in the fruit/vegetable (Barba *et al*., 2012).

This preference is also reflected in the gradual decrease in appearance ratings as the carrot content decreased. The discriminative effects of taste and appearance on the acceptability of beverages are well reported (Aderinola, 2018). Although, there was no statistically significant difference, sample D {50:50} which, comparatively, showed better antioxidative propertives {Figure 2III, IV} was poorly rated in taste, aroma, mouthfeel and hence in overall acceptability. A similar trend of poor ratings for samples with better antioxidative properties has also been reported (Aderinola, 2018). In summary, while there were no statistically significant differences in the ratings, the overall acceptability results indicated that carrot juice was preferred due to the higher ratings.

4. CONCLUSIONS

This research demonstrates that carrots and cucumbers possess significant levels of vitamins, minerals, and macronutrients essential for the body's proper functioning. Carrot is well-known for its high Vitamin A content, so blending it with cucumber enhanced the nutritional value of cucumber juice. The research showed that mixing carrot and cucumber resulted in enhanced bioactivity {antioxidant properties}, with the best bioactivity observed at a 50:50 ratio compared to the separate juices.

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