

Physico-chemical and sensory properties of soft drinks made from the tuberous root of beetroot (*Beta vulgaris*)

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Abstract

Beetroot soft drink is a drink that uses beetroot juice as the main ingredient, which is extracted and mixed with water, sugar, acidulants and flavourings during the manufacturing process. The aim of this study was to produce beetroot-based soft drinks, evaluate the conformity of the physico-chemical parameters and carry out a sensory analysis. Three (3) soft drink formulations (A), 19% beetroot juice, 20% simple syrup; 1% lemon juice, 60% carbonated water; (B), 14% beetroot juice, 25% simple syrup; 1% lemon juice, 60% carbonated water; (C), 9% beetroot juice, 30% simple syrup; 1% Lemon juice, 60% carbonated water, were produced and characterised in the laboratory of the Higher Polytechnic Institute of Gaza, in terms of total titratable acidity by titration with NaOH at 0.1 M, using the electrometric procedure, total soluble solids content by refractive index in a refractometer and sensory analysis using affective methods. The data was statistically analysed using MiniTab Version 18 statistical software and Excel to draw up tables. The results showed variations in the physico-chemical parameters: 0.185 ± 0.09 to $0.241 \pm 0.06\%$ for total titratable acidity, 2.66 ± 0.007 to 2.73 ± 0.01 for pH and 9.36 ± 0.14 to $12.34 \pm 0.16^\circ$ Brix for total soluble solids content. Sensorially, the soft drink with 9% Beetroot juice, 30% Simple syrup; 1% Lemon juice, 60% carbonated water, showed the best appearance, flavour, aroma and overall assessment with acceptance averages of over 7. The purchase intention test showed that 45.3% of the tasters said they would "buy" formulation C, and both formulations achieved the acceptability index with 71.2%, 79.2% and 88.2% for formulations A, B and C, respectively. the production of beetroot-based soft drinks shows promise both in terms of compliance with regulatory standards and sensory acceptance by consumers.

Keywords: Soft drinks, compliance, sensory acceptance

Introduction

The increase in awareness of healthy eating has been gaining ground and, allied to this, there is a growing concern for health and well-being on the part of consumers looking for natural, nutritious and beneficial foods. However, there is little diversification in the use and consumption of tuberous beetroot, mainly in the beverage industry, thus producing nonalcoholic beverages. This root is known for its richness in nutrients, such as vitamins, minerals and antioxidants, and is seen as a healthy food since: it fights anaemia, because it contains iron, contributes to lowering blood pressure, fights cancers and cardiovascular diseases (Paulo, 2016).

Consumption of non-alcoholic beverages has been growing worldwide, as they have health appeals and are considered more natural drinks. The demand for these drinks is largely based on their nutritional value, as natural juices provide vitamins, minerals and antioxidants. On the one hand, it has to be considered that scholars of beverages do not hesitate to state that one of their functions is, in fact, nutritional and, therefore, argue that beverages are food (Wireko-Manu *et al.*, 2017)^[11].

Beetroot soft drink is a drink that uses beetroot as one of its main ingredients. The process usually involves extracting the beetroot juice and then mixing it with other ingredients such as water, sugar, acidulants and flavourings. The result is a reddish-coloured drink, which can be somewhat reminiscent of the taste of beetroot, but is also combined with the other flavours present in the formula (Wireko, 2017)^[11].

Consumption of plant-based products has increased, driven by consumers looking for more natural and sustainable alternatives. The beverage industry is always looking for new flavours and ingredients to stand out in the market and ensure that their properties or characteristics meet the standards or norms recommended for this type of product (Cozzolino, 2019)^[9].

According to the Catalogue of Mozambican Standards Decree NM 223: 2010 Ed.1, soft drinks are produced in accordance with the physical-chemical specifications that give them their basic characteristics, such as: °Brix (sweeter/less sweet) and acidity (more acidic/less acidic), (NM 223:2010).

The aim of this study was to produce beetroot-based soft drinks and to assess the compliance of the physico-chemical parameters (pH, soluble solids and total titratable acidity) in accordance with Mozambican legislation and to carry out a sensory analysis to check the level of acceptability of this product by consumers.

Materials and methods

Place of study

The study was carried out at the laboratory of the Higher Polytechnic Institute of Gaza (ISPG), Lionde administrative post. According to MAE (2014), the district of Chókwè is located in the south of Gaza province, in the middle of the Limpopo River, bordered to the north by the Limpopo River, to the south by the districts of Bilene, Mazimuchope and XaiXai, to the east by the districts of Bilene and Chibuto and to the west by the districts of Magude and Massingir.

Vegetables account for more than 20 per cent of monthly household expenditure on food INE (2010), which shows the key role of vegetables in food and nutritional security and in combating rural and urban poverty. The domestic market is supplied by national and imported vegetables. The main vegetables produced in Chókwe are tomatoes, onions, cabbage, peppers, beetroot, garlic, lettuce, kale and carrots. However, the variety of products is gradually expanding to include processed or value-added foods such as pre-washed vegetables (Haber *et al.*, 2015).

Purchase of raw materials

10kg of beetroot, 3kg of brown sugar and 5L of aQuellé brand sparkling water were purchased from the Chókwe municipal market. During purchase, characteristics such as texture, colour (reddish-purplish), shape, absence of cracks and an unpleasant smell were meticulously assessed. As for the sugar and sparkling water, the expiry date, the integrity of the packaging and the net weight were checked. All the items were then transported to the food processing laboratory at the Higher Polytechnic Institute of Gaza (ISPG).

Production process

Weighing and washing

Using a HANNA scale, accurate to 0.001g, the ingredients were weighed according to the quantities shown in Table 1. The beetroot was washed by immersion in running water in order to remove impurities, loose particles and surface residues that might have adhered to its outer surface.

Peel and chop

The process of peeling and cutting the vegetables (beetroot) was carried out meticulously using a stainless steel knife. Initially, the beetroots were peeled by hand, carefully removing the outer layers and any inedible parts. Subsequently, precise cuts were made, resulting in thin slices that facilitate the subsequent grinding process.

Bleaching

Blanching was carried out in order to soften the beetroot to aid the grinding process and also to inhibit enzymatic browning. To do this, the beetroots were placed in a preheated water bath, where they were immersed in hot water maintained at a temperature of 90°C for a period of 5 minutes. After the blanching stage, the excess water was drained off and the beetroots were cooled until they reached room temperature, around approximately (± 25 °C).

Extracting the juice

This process consisted of putting the beetroots through a HOBART vegetable shredder at a single speed of 1,500 rpm for 5 minutes, fitted with 4 stainless steel blades with a metal hub. After this process, the crushed pulp was removed to extract the juice by squeezing. The beetroots were crushed for 5 minutes, resulting in a finely fragmented pulp. The crushed pulp was then removed for extraction of the juice by squeezing.

Simple syrup production

The production of simple syrup involved obtaining the product by diluting crystal sugar in hot water at a temperature of 80°C. This process was carried out using 500 ml of water, in which precisely 125 grams of sugar were dissolved.

Production of compound syrup

The simple syrup was added to the concentrate extracted from the beetroot pulp, which was essential for imparting flavour, aroma and sweetness to the drink. This stage was carefully carried out under constant agitation, using a "back and forth" stirrer on the bottle containing the components. The stirring process was maintained for a period of 3 minutes, ensuring complete homogenisation of the different elements.

Carbonation

The carbonation stage involved adding carbonated water to the drink to give it its characteristic effervescence. This process was carried out at controlled temperatures of between 10 and 17°C, providing ideal conditions for the efficient dissolution of the carbon dioxide in the solution.

Packaging

Filling was carried out manually, after the carbonated water had been injected through a reducer made from HDPE-LLDPE polypropylene, the bottle was hermetically sealed and constantly shaken for 5 minutes to allow the gas to dissolve more thoroughly.

Formulations

To make the beetroot-based soft drink, as shown in Table 1, three (3) different compositions were formulated, called treatments. The variations between the treatments were related to the specific amount of beetroot juice and simple syrup incorporated.

Table 1: Formulations of beetroot-based soft drinks.

Ingredients (%)	Formulations		
	A	B	C
Beetroot juice (ml)	19	14	9
Simple syrup (ml)	20	25	30
Lemon juice (ml)	1	1	1
Carbonated water (ml)	60	60	60
Total (%)	100	100	100

Legend: A-19% Beetroot juice, 20% simple syrup; 1% Lemon juice, 60% carbonated water; B -14% Beetroot juice, 25% simple syrup; 1% Lemon juice, 60% carbonated water; C- 9% Beetroot juice, 30% simple syrup; 1% Lemon juice, 60% carbonated water.

Source: Authors.

Physico-chemical analysis

In accordance with the analytical guidelines established by the Adolfo Lutz Institute (IAL, 2008), a physico-chemical analysis was carried out, determining the following parameters: pH, titratable acidity and soluble solids.

Determination of hydrogen potential

With the aid of a HANNA digital potentiometer (HI 2212 pH/ ORP Meter), calibrated with buffer solutions of 4.0, 7.0 and 10.0. The pH values were determined in triplicate using electrometric procedures involving potentiometric apparatus, enabling direct pH determination, where 10mL of the sample was transferred to a 50mL beaker.

Determination of soluble solids content

Soluble solids were determined by refractometry using a digital refractometer (Refractive index 1330-14098) with a scale ranging from 0 to 45 °Brix.

Determination of total titratable acidity

The acidity level was determined using the titrimetric method, where 10ml of the sample was transferred into a 100ml Erlenmeyer flask containing 50ml of distilled water, then the mixture was homogenised by hand for two (2) minutes, then titrated with 0.1N sodium hydroxide solution under constant agitation until the turning point (presence of a pink colour). The acidity values were calculated using equation 4, and the results expressed as a percentage (%) of (v/m or m/m).

$$\text{Total titratable acidity (\%)} = (V * N * \text{Meq}) / (P) \text{ (Equation 1)}$$

Where:

V - Volume of NaOH used in the titration in ml;

N = Normalised NaOH (0.1 M);

Meq = Milliequivalent of the acid, 0.064 for citric acid;

P - sample mass in g or pipetted volume in ml;

Sensory analysis

The sensory analysis was carried out on a panel made up of 50 untrained tasters, randomly selected from students, teachers and employees of both sexes aged between 18 and 50. They were subjected to the acceptance test where they evaluated the following attributes (appearance, aroma, flavour, texture, colour, odour and overall rating) on a 9-point hedonic scale for the three formulations. The acceptance index (AI) was calculated using the equation below:

$$\text{AI} = (A * 100) / B \text{ (Equation 2)}$$

Where

A - Represents the average score obtained for the product; B - Maximum score given to the product.

Statistical analysis

The effects of the treatments were subjected to analysis of variance (ANOVA) and the means were compared using the TUKEY test at a 5% significance level, using the MiniTab statistical package version 18.1. A completely randomised design with 3 experimental units was used to analyse the physico-chemical parameters and a randomised block design with 50 experimental units was used for the sensory analysis. If there were significant effects, the difference between the means of the experimental units was evaluated using the Tukey test at the 5% level.

Results and discussion

The results obtained from the evaluation of the physicochemical properties of the soft drink made from beetroot are shown in Table 2, comprising total titratable acidity, hydrogen potential and total soluble solids at Brix.^o

Table 2: Results of the physico-chemical characterisation of the beetroot-based soft drink.

Parameters	Treatments		
	A	B	C
ATT (%)	0,20±0,04 ^{ab}	0,24±0,06 ^a	0,18±0,09 ^b
pH	2,73±0,01 ^a	2,66±0,007 ^b	2,66±0,013 ^b
TSS (° Brix)	9,36±±0.14 ^c	11,55±0,18 ^b	12,34±0.16 ^a

Mean ± standard deviation, the same letters on the same line indicate that there were no statistical differences at the 5% level using the Tukey test. Legend: ATT - Total titratable acidity; pH -

Hydrogen potential; TSS - Soluble solids content; Legend: A - 19% Beetroot juice, 20% Simple syrup; 1% Lemon juice, 60% carbonated water; B -14% Beetroot juice, 25% Simple syrup; 1% Lemon juice, 60% carbonated water; C- 9% Beetroot juice, 30% Simple syrup; 1% Lemon juice, 60% carbonated water.

Source: Authors.

Total titratable acidity

Analysing the total titratable acidity revealed statistically significant differences between formulations B and C, with averages of 0.185% and 0.241% respectively. This variation can be attributed to the interaction between concentrations of citric acid, a bioactive present, and soluble solids, making organic acids more available.

These values are higher than the results obtained by Mamo *et al.* (2018) ^[13] in their study on tropical fruit blends with plant extracts, which ranged from 0.65% to 0.75% citric acid.

Wireko-Menu *et al.* (2017) ^[11], when developing a non-alcoholic drink from cassava and sweet potato, obtained values of 0.31% to 0.37%, which suggests a direct influence on the acidity of the drink.

Similar results to formulations A and B were reported by Assis *et al.* (2019) ^[4] in their study on pineapple blends with added beetroot juice, with 0.205% citric acid.

Results close to those of formulation C were found by Sohail *et al.* (2016) ^[23] in their study on fruit juice, mixing beetroot and pineapple, with values in the range of 0.17% to 0.18% when they prepared a sweet potato drink with beetroot juice.

According to Mozambican Decree No.^o 223: 2010 of the National Institute for Standardisation and Quality (INOQ), the minimum titratable acidity of soft drinks should be 0.02%. The results of the samples analysed in this study are in line with the Mozambican standard (NM 223:2010).

pH

Formulation A of the beetroot-based soft drink showed statistically significant differences from the others, with the highest average pH of 2.73, followed by formulations B and C, both with a pH of 2.66. The lower pH values in formulations B and C are attributed to the differential amount of beetroot juice, influencing the presence of acidic compounds due to the varying concentrations of organic acids.

In agreement, Rodrigues *et al.* (2012), in their preliminary studies for the production of soft drinks from pineapple juice, found pH values between 2.625 and 3.615, in line with the results observed in this study.

On the other hand, Wireko-Manu *et al.* (2016), when developing a non-alcoholic drink from cassava and sweet potato, obtained higher values, ranging from 3.53 to 4.20, associated with the acidification levels of this drink.

(2018), developing a mixed grape and beetroot (*beta vulgaris*) drink, found higher values between 3.26 and 4.50, and these differences may be associated with the acidification levels of this drink.

And similar and close values were reported by Araújo *et al.* (2017) ^[3] when producing a gingerbased detox soft drink, finding levels in the range of 2.31 to 3.94.

In accordance with the Mozambican standard of Decree No. 223:2010 Ed.1 of the National Institute for Standardisation and Quality (INOQ), which establishes minimum pH values for soft drinks ranging from 2 to 4.5, it can be assumed that the results of the samples analysed in this study are in line

with the standards established by the Mozambican standard (NM 223:2010).

Total soluble solids

There were statistical differences in the soluble solids content with the lowest average of 9.36⁰ Brix observed in formulation A and the highest average of 12.34⁰ Brix recorded in formulation C. The significant differences in soluble solids content observed in the soft drink formulations were due to the different amounts of simple syrup added, with a slight increase in formulations A and C, which caused a gradual increase in this parameter as more syrup was used.

The values obtained in this study are higher than those observed by Araújo *et al.* (2017)^[3] in the experimental trial Production of Ginger Detox, which ranged from 8.50 to 10.80⁰ Brix, differences which are linked to the sweetness of this drink.

Santos *et al.* (2018)^[20] studied mixed orange and sweet potato juice and reported values in the range of 9.20 to 13.92⁰ Brix, which are in agreement with the values found in this study. Reis *et al.* (2016)^[18], in their study on the development and characterisation of pineapple soda (pineapple *comosus*) with mint (*mentha x villosa*), obtained values of⁰ Brix that ranged from 8 to 12⁰ brix, values that are in agreement with this study.

Sohail *et al.* (2016)^[23] reported values in the range of 8.20 to 13.92⁰ Brix, which is within the range observed in this study.

According to decree n^o 223: 2010 Ed.1 of the Mozambican standard establishes the limits of the percentages of⁰ Brix acceptable for refringents, which must not be less than 8^oBrix (NM 223:2010).

Sensory analysis

The results of the acceptance test carried out on a hedonic scale of 1 to 9 points for the three formulations of soft drinks based on tuberous beetroot are shown in Table 3.

Table 3: Sensory analysis of beetroot-based soft drinks.

Attributes	Treatments		
	A	B	C
Appearance	6,68±1,96 ^a	6,88±1,17 ^a	7,18±1,94 ^a
Colour	8,05±2,05 ^a	7,35±1,85 ^{ab}	6,69±1,76 ^b
Flavour 1	6,98±1,82 ^b	7,35±1,81 ^{ab}	8,25±2,02 ^a
Flavour 2	6,96±1,53 ^c	7,40±2,00 ^b	8,41±1,71 ^b
Overall assessment	6,45±1,80 ^a	7,13±1,64 ^{ab}	7,66±1,77 ^b

Mean ± standard deviation, the same letters on the same line indicate that there were no statistical differences at the 5% level using the Tukey test. Legend: ATT - Total titratable acidity; pH - Hydrogen potential; TSS - Soluble solids content; Legend: A - 19% Beetroot juice, 20% Simple syrup; 1% Lemon juice, 60% carbonated water; B - 14% Beetroot juice, 25% Simple syrup; 1% Lemon juice, 60% carbonated water; C - 9% Beetroot juice, 30% Simple syrup; 1% Lemon juice, 60% carbonated water.

Source: Authors.

Appearance

No statistically significant differences were found between the formulations with regard to the appearance attribute, with averages ranging from 7.18 to 6.88. This indicates that the beetroot concentrate present in formulations A, B and C had no discernible impact on the appearance of the soft drinks.

In previous studies, Mamo *et al.* (2018)^[13] reported lower values, ranging from 6.55 to 5.50, on the hedonic scale of

"neither liked nor disliked" to "slightly liked", when evaluating blends of tropical fruits with plant extracts.

The averages obtained in this study are higher than those observed by Araújo *et al.* (2017)^[3] in their research on ginger detox production, where the averages ranged from 4.30 to 5.10. In a study of cassava and sweet potato non-alcoholic beverages conducted by Wireko-Manu *et al.* (2016), averages in the range of 6.20 to 7.13 were found, values in line with those found in this study.

Assis *et al.* (2019)^[4], when analysing four pineapple blend formulations with added beetroot juice, observed even higher averages, ranging from 7.87 to 8.53, higher than the averages recorded here. These variations in appearance evaluations may be related to the specific composition of the formulations and the subjective perception of consumers.

Colour

Statistically, formulation B (7.35) did not differ significantly from formulations A and C. However, there was a significant difference between samples A and C, with average acceptance ratings ranging from 6.69 to 8.05, respectively.

The disparity between formulations A and C can be attributed to the greater amount of simple syrup added to formulation C and the greater amount of beetroot concentrate in formulation A, intensifying the red-purple colour of the soft drink.

In a study by Sohail *et al.* (2016)^[23] on the sensory analysis of fruit juice developed from a mixture of beetroot (*Beta vulgaris*) and pineapple (*Ananas comosus*), the highest average acceptance rating of 8.4 was found, a result in agreement with those obtained in the present study for this attribute.

Rodrigues *et al.* (2017), in their preliminary studies for the elaboration and sensory analysis of soft drinks made from pineapple juice, found an average of 6.7 for this attribute.

Similar results were observed by Machado (2019)^[12] when he evaluated orange juice in combination with beetroot from the processing stages of concentrated and frozen juice, finding a variation in the average from 6.63 to 8.67.

Albuquerque *et al.* (2017)^[1] found higher averages in their study on the preparation and sensory evaluation of yoghurt with the addition of sweet potato and beetroot flour, reporting averages between 8.79 and 9.35 in hedonic values of "I liked it very much" and "I liked it a lot".

Flavour 1

Formulation B did not show a statistically significant difference compared to formulations A and C, receiving a score of 7.35. However, formulations A and C showed a statistically significant difference between them, with formulation A achieving the lowest average of 6.98 and formulation C achieving the highest average of 8.25.

Formulation A, which had the lowest average, may have been influenced by the low concentration of sucrose syrup added, resulting in a less sweet flavour, and formulation C by the higher concentration of sucrose added.

This result is in line with the observations of Braga *et al.* (2020)^[6], who point out that acceptance of the flavour attribute in food products is generally associated with a higher concentration of sucrose.

Carnio *et al.* (2023)^[8] (4.10 to 5.17) reported lower levels of acceptance of the flavour attribute in grape-flavoured soft

drinks than those found in this study. These differences can be attributed to the specific characteristics of the formulations and the individual preferences of consumers.

Similar results were observed by Mamo *et al.* (2018) ^[13] 6.71 in sensory analyses of orange drinks added with carrot juice, as well as by Belizário *et al.* (2017) 7.75 in mixed acerola, watermelon and beetroot drinks.

Silva *et al.* (2020) ^[22], in their study of red fruit soft drinks enriched with beetroot juice, found averages 7.88 to 8.67 higher than those observed in the present study, indicating a possible positive influence of beetroot juice on sensory acceptance.

Flavour 2

Formulations B and C, with averages ranging from 7.40 to 8.41, showed no statistically significant differences between them. However, both were statistically different from formulation A, which had an average of 6.96. This disparity can be attributed to the greater amount of beetroot juice in formulation A, which contributed to a less desirable flavour in the soft drink.

Similar results were observed by Reis *et al.* (2016) ^[18], who found averages between 6.96 and 7.40 during the development of a pineapple-mint flavoured soft drink. Steffler *et al.* (2018) ^[24] also reported averages between 6.30 and 6.87 in their study on the sensory analysis of guarana soft drink acceptability.

Albuquerque *et al.* (2017) ^[1], when evaluating a yoghurt with the addition of sweet potato and beetroot flour, found averages between 6.59 ± 1.27 and 7.84 ± 0.88 , results similar to those of the present study.

Machado (2019) ^[12], when evaluating orange juice in combination with beetroot, obtained a range of averages from 6.20 to 8.37, results that are in agreement with the averages found in this study for this attribute.

On the other hand, Carnio *et al.* (2023) ^[8] published lower results, ranging from 4.94 to 6.27 among five grape soft

drinks in their study on sensory acceptance. These differences can be explained by the different compositions of the formulations, concentrations of ingredients and individual consumer preferences.

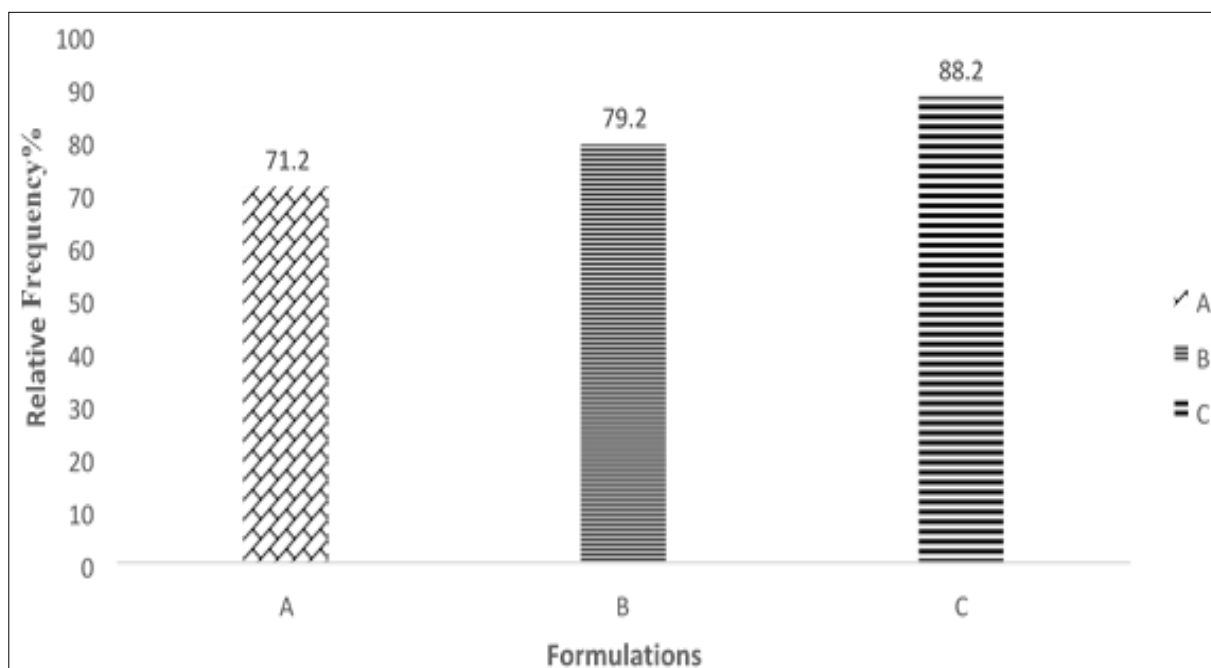
Overall assessment

There were significant differences between formulations A and C with averages ranging from 6.45 to 7.66 respectively, but formulation B did not differ from the two formulations with an average of 7.13. The significant difference observed between formulations A and C may have been due to differences in the concentrations of sucrose simple syrup and beetroot juice added to each one.

Therefore, the higher average observed in formulation C may have been due to the good acceptance of the attributes of good flavour, good appearance and a good aroma, as evidenced by the high averages obtained for these attributes. Similar results to those obtained in this research were reported by Nadeem *et al.* (2017) ^[14] in their study on the impact of fruit pulp blends on the sensory quality of ready-to-drink beverages, with averages ranging from 6.00 to 7.30. Criveletto (2016) ^[10], Belizário *et al.*, (2017) and Araújo *et al.* (2017) ^[3], obtained scores ranging from 6.4 to 8.75 in the overall assessment, in studies of the physicochemical and sensory stability of beetroot-based soft drinks with added orange juice, Processing and analysis of mixed acerola, watermelon and beetroot juice and in the experimental trial Production of Ginger Detox. These averages are in agreement with the range of values assigned in this study.

Acceptability index

The acceptability index summarises the acceptability of all the sensory attributes analysed in the product. Graph 1 illustrates the results of the acceptability index for the soft drink based On tuberous beetroot.



Graph 1: Acceptability index of soft drinks based on tuberous beetroot

Caption: **A** - 19% Beetroot juice, 20% simple syrup; 1% Lemon juice, 60% carbonated water; **B** - 14% Beetroot juice, 25% simple syrup; 1% Lemon juice, 60% carbonated water; **C**- 9% Beetroot juice, 30% simple syrup; 1% Lemon juice, 60% carbonated water. **Source:** Author

The acceptability index for formulations A, B and C, with percentages of 71.22%, 79.44% and 88.22% respectively, revealed a pattern of progressive increase as the amount of sucrose syrup increased in each formulation. This trend suggests a preference among tasters for sweeter products, reflecting a direct relationship between the amount of sucrose and the acceptability of the product.

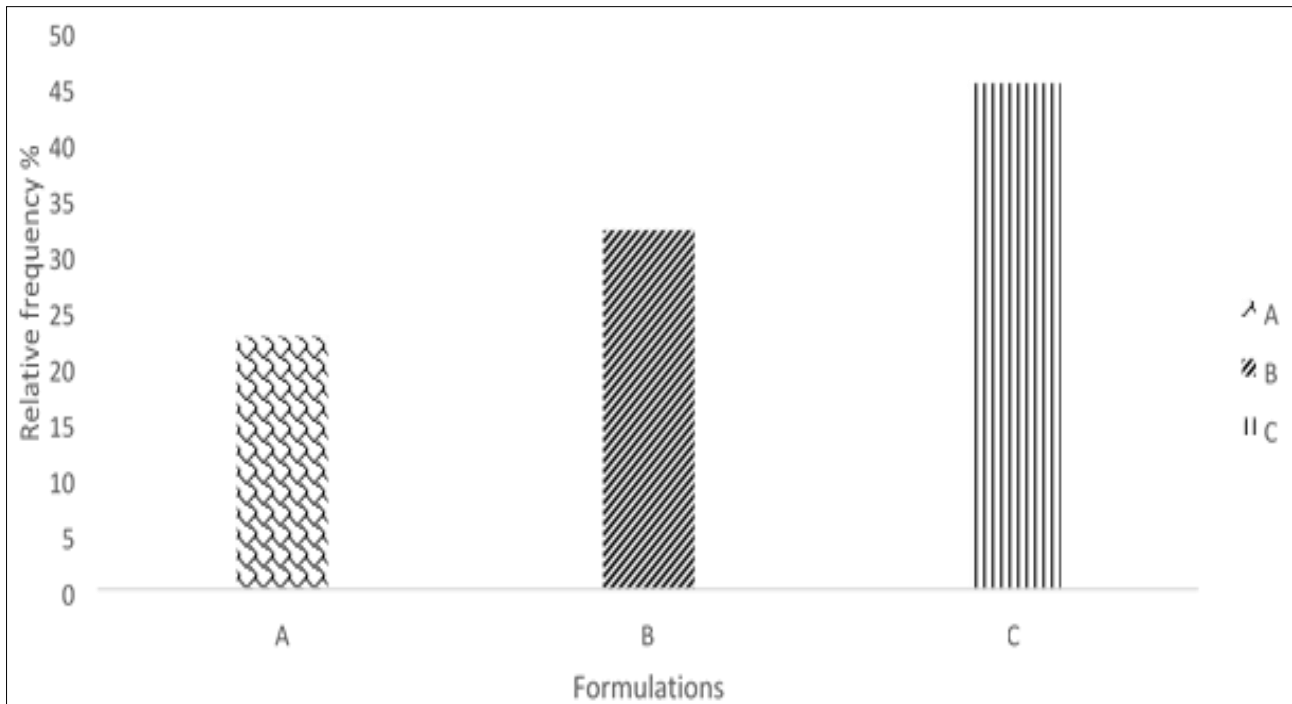
According to Noronha (2003), a product is considered acceptable in sensory terms when it achieves a minimum acceptability index of 70 per cent. All three formulations evaluated in this study met these guidelines, which indicates good overall acceptance of the formulations by the tasters.

Cáceres (2017)^[7], Sohail *et al.* (2016)^[23] and Santos (2018)^[20] identified acceptability rates ranging from 75% to 91%

in research related to the production of beetroot drinks, sensory analysis of fruit juice combining beetroot and pineapple, and the production of mixed orange and sweet potato juice. These averages are in line with the results of this study, corroborating the positive trend of acceptance of the formulations produced.

Purchase intention

The results obtained from the analysed soft drink attributes showed that all the soft drink formulations based on tuberous beetroot evaluated were acceptable and in terms of purchase intention, each of the tasters would buy at least one of the soft drink formulations, as illustrated in graph 2.



Graph 2: purchase intention test for soft drinks based on tuberous beetroot

Caption: A - 19% Beetroot juice, 20% simple syrup; 1% Lemon juice, 60% carbonated water; B - 14% Beetroot juice, 25% simple syrup; 1% Lemon juice, 60% carbonated water; C- 9% Beetroot juice, 30% simple syrup; 1% Lemon juice, 60% carbonated water. **Source:** Authors

The results obtained from the research into the purchase preference of the soft drinks produced revealed that formulation C was the most sensorially accepted, with a purchase preference percentage of 45 per cent, followed by formulation B with 32 per cent, and lastly formulation A with 22 per cent. This preference can be attributed to the higher concentration of sucrose added to formulation C.

As observed by Oliveira *et al.* (2015)^[17], the addition of sucrose to food products tends to enhance their sensory characteristics, which may explain the higher purchase intention value associated with the formulation with the highest sucrose concentration.

Oliveira (2018) investigated the acceptance of mixed orange juice with beetroot and Silva *et al.* (2020)^[22] developed a red fruit soft drink enriched with beetroot juice, also identifying purchase intention values varying between 30% and 50%, respectively.

Therefore, based on the results obtained, it can be concluded that the majority of tasters (99%) were interested in buying the product produced in the research, which is in line with

the results of the acceptance test. This behaviour suggests that formulation C, with a higher sucrose concentration, had a positive response from consumers, reinforcing the importance of sensory aspects in the purchasing preference of food products.

Conclusion

It became clear that the production of beetroot-based soft drinks could be a promising alternative for meeting consumer demands for more natural and healthy products. The formulations developed complied with the physicochemical parameters established by Mozambican legislation (decree n^o 223:2010 of the National Institute for Standardisation and Quality), demonstrating that it is possible to produce beetroot soft drinks within the required standards.

Formulation C (with 9% beetroot juice, 30% simple syrup; 1% lemon juice, 60% carbonated water) was the most acceptable of all the formulations, with an acceptability index of over 70%.

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