DETERMINATION OF METABOLIC ENERGY BY THE CRABTREE EFFECT, IN A NATURAL CAROM SOFT DRINK

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The present research was carried out in the laboratory of biological sciences was elaborated a natural soft drink using the carom with different levels of glucose (5%, 10%, 15% and the control), the best treatment was defined by physicochemical, microbiological and sensory analysis. The statistical tests were a completely randomized design, analysis of variance, and Tukey's test for mean separation ($P<0.05$); Sensory analysis was performed with an affective test with untrained panelists. The results were that the glucose level does interfere with the physicochemical, microbiological and sensory parameters of the drink, concluding that the glucose level at 10% and 15% are the most convenient because they are within the parameters of the INEN standard for carbonated beverages (NTE INEN 1101: 2017). While in the organoleptic characteristics the drink with 15% glucose had greater acceptance by the panelists.

Keywords: < Carambola>, <Soft drink>, <Glucose>, <Physicochemical characteristics>, <Microbiological analysis>, <Fruit>.

I. INTRODUCTION

The star fruit (*Averrhoa carambola*) also called star fruit for its shape is a perfect sustenance since it contains calcium, magnesium, phosphorus and vitamin C, also provides the body with 40 calories per 100 grams of fruit (Cagua D, 2015.p.1). To give added value to the manufacture of products derived from fruits, different preservation methods are applied, with which a series of alterations are carried out so that macroorganisms, chemical and enzymatic reactions cannot progress Balladares, A (2019, p.8).

According to Belén at al (2011, p. 684), fermented foods have always been a hot topic in the agri-food industry and have evolved over the years from an empirical concept of what it is to preserve a food to a highly controlled process. Fermented soft drinks attract attention for the "bubbles" they create, which are beneficial and improve the taste and feel of the drinker. Some fermentation processes do not need mother cultures, so they are fermented with the presence of yeast that the fruits have (Angulo & Troyes, 2019).

Therefore, the specific objectives of this study are to verify if there is presence of yeast in the star fruit that help the fermentation process with different levels of glucose (5, 10, 15) % and the amount of CO2 and ethanol of the final drink, the physicochemical, microbiological and sensory characteristics of the same will be analyzed.

II. RESEARCH METHODOLOGY

The study was carried out in the province of Chimborazo, Riobamba canton at an altitude of 2850 meters above sea level with an average temperature of 22° C and an average relative humidity of 60.9% at the Polytechnic School of Chimborazo (ESPOCH), faculty of livestock sciences, laboratory of Biological and Bromatological Sciences. The duration of the research was 90 days where the different studies referred to were carried out.

EXPERIMENTAL UNITS

In the investigation, physicochemical and sensory parameters were evaluated, the experimental unit consisted of 250 ml of sample per replica, 1000 ml per treatment and 4 replicates with a total

of 4000 ml. The main raw material used for the production of soft drink was the carambola (*Averrhoa carambola)* obtained from the Lago Agrio canton in the province of Sucumbios.

EXPERIMENTAL MEASUREMENTS

For the research, the physicochemical and microbiological variables for the fruit were analyzed; pH, total solids, soluble solids, acidity, fermentable sugars and beneficial yeast count, in the beverage the pH was established. Acidity, soluble solids, carbon dioxide and alcohol. For the microbiological analysis, yeasts were analyzed and finally for the sensory analysis it was carried out through an affective test of acceptance of the product with untrained tasters.

STATISTICAL ANALYSIS AND SIGNIFICANCE TESTS

Statistical tests were performed that were a completely randomized design, analysis of variance (ADEVA), and Tukey's test for mean separation ($P<0.05$).

III. RESULTS AND DISCUSSIONS

MICROBIOLOGICAL ANALYSIS OF FRUIT

YEAST CONTENT

Table 1: Physicochemical characteristics and yeast content of carambola

Variables	Med	Standard deviation	Minimal	Maximum
Levaduras *(Saccharomyces cerevisiae)*	8,67	± 4,51	4	13
pH	2,50	± 0,10	2,4	2,6
Acidity	0,62	± 0,02	0,59	0,63
Soluble solids	6,87	± 0,38	6,6	7,3
Fermentable sugars	2,17	± 0,54	1,80	2,79

As a result in the microbiological analysis of the present study, 8.67 CFU/ml was obtained. What bibliographically (Escobar, Benedetti and García, 2018, p.128) who carried out the yeast count for carom pulps *(Averrhoa carambola)* pulps the maximum limit allowed is $3x10^2$ CFU / g, so it is within the range of the regulations.

PHYSICOCHEMICAL ANALYSIS OF THE FRUIT

PH

For the pH analyzed, a minimum value of 2.4 and a maximum of 2.6 were obtained with an average of 2.5 ±0.10, so the star fruit is considered a moderately acidic fruit. This suggests that the carambola has an abundance of organic acids such as oxalic and malic acid which cause the pH to drop (Gonzales & Hernandez, 2010, p.60).

ACIDITY

The results obtained of oxalic acid level is an average of 0.62% value that is within the range reported in the research of Cubillos & Izasa (2009, p.36) where acid values of 0.62% were found, which indicates results equal to those reported in this study. From another point of view according to Gavica & Terán, (2011, p.15) mention that the organic acids that are present in fruits go down from % when they ripen this happens by respiration or their conversion into sugars.

SOLUBLE SOLIDS

The total solids analyzed of the fruit resulted in an average of 6.87 ± 0.38 brix, these data are similar to the study of semi-ripe fruits (Cubillos and Izasa, 2009, p.37) with 7ºBrix. Gavica and Teran (2011, p.15) obtained results of 13.0 ºBrix in ripe carom fruits. As the fruit ripens on the tree, the sugar concentration increases and the acidity decreases, so the soluble solids in the analyzed fruit can be 6.87ºBrix (Vallejo, 2011, p.48).

FERMENTABLE SUGARS

In the results obtained from the fermentable sugars of the carom fruit, a minimum of 1.80 g / L and a maximum of 2.79 g / L were obtained, giving us an average of 2.17 ±0.54 these results are in the parameters mentioned by Jiménez (2011, p. 155) who obtained fermentable sugars from (*Beta vulgaris L),* presenting values of 2 g/L These changes may be due to changes in ripeness, fruit type or concentration (Acosta 2013, p.58-60).

PHYSICOCHEMICAL ANALYSIS OF CARBONATED BEVERAGE

PH

As results of the pH of the carom soda drink in Table 2, highly significant differences ($p<0.01$) were reported between means, due to the different glucose levels, The lowest result was determined using 15% glucose with a value of 3.68 and the highest value was 4.68 using 0% glucose, inferring a decrease in pH at higher glucose levels given by Arias (2013, pp. 21-22), who states that sugars are the most important raw material for the development of yeast and that during fermentation, fermentable sugars are converted into carbon dioxide, which is confirmed by (Martelo and Porto, 2011, pp. 78-79), who mentions the purpose of CO2 preserves the drink by slightly lowering the pH.

According to (Castillo & Cornejo, 2017, pp. 3-5), the change in pH content may result from the fact that the reactions of sugars to acids are increased under the influence of the fermentation rate, resulting in a higher concentration efficiency of hydrogen ions, resulting in a lower pH in the final product.

Table 2. Physicochemical analysis of carom soda with different glucose levels

	Glucose Levels							
Variable	**0%**		**5%**		**10%**		**15%**	
pH **	4,68	a	4,15	b	4,05	b	3,68	c
Acidity ns	0,32	a	0,34	a	0,35	a	0,37	a
Soluble solids **	1,53	d	4,70	c	8,98	b	12,03	a
Alcohol **	0,00	c	1,31	b	1,97	a	1,97	a
Carbon Dioxide **	0,00	d	1,83	c	2,18	b	2,90	a

ACIDITY

The acidity results of Table 2 show that the values obtained from the soda did not present statistically significant differences (P>0.05), but numerical superiority was evaluated in the data presented for the 15 glucose sodas. with an average of 0.37% and the lowest values were from the control drink with 0 glucose, with an average of 0.32%, these data are within the limits determined by Remache (2015, p. 61), who made a fermented orange drink. Giving an acidity of 0.37%, equivalent to a carbonated drink with a glucose content of 15%.

According to (NTE INEN 1101), which refers to Carbonated Beverages, it indicates that the acidity assumes a maximum value of 0.5% for these beverages, whose results are within the requirements established by the standard, which is confirmed by Ponce (2012, pp. 89-90). He mentions that fruit-based drinks should have between 0.3 and 0.6% acidity.

SOLUBLE SOLIDS

When analyzing the soluble solids of the beverage, results were reported with significant differences (p<0.01) between the means, being the beverage with 15% glucose the one with the highest value, which can be seen in Table 2, with an average of 12.03º Brix and the lowest value corresponding to the beverage with 0% glucose, with a value of 1.53º Brix, agreeing with the ranges of 11 to 13º Brix presented in the research of Yánez (2006), which elaborated a soft drink using clarified pineapple juice presenting. As well as higher values of 13.7 presented by Maldonado and Moncayo (2012, p.36), which according to Alfaro & Muñoz (2013, p.45-46) this variability is due to the content of sugars in the drink.

According to the (NTE INEN 1101), of carbonated beverages soluble solids require a maximum value of 15.0º brix, which the results obtained in the different levels of glucose plus the control, meet the requirements required by the standard.

ALCOHOL

When performing the alcohol measurement tests indicates that ay highly significant differences, between the means, reflected in table 2, in which the treatments of 10 and 15% of glucose obtained the highest values with 1.97% of alcohol in both cases, and on the contrary the treatment with 0% of glucose reported a value of 0% of alcohol being this the most low, sugar being the main indicator of alcohol content in the drink, since, as indicated by Roldón, (2021,p.1.) Sugars are the main food for the development of yeasts and that they have an important enzyme: zimase, which transforms glucose into alcohol and carbon dioxide.

When comparing these values with several authors, a similar behavior is reflected in terms of the behavior of alcohol content in relation to sugar content, indicating that glucose is the most essential carbohydrate for the development of yeasts and that during fermentation sugars are transformed into ethanol, according to Valisek (2016, p.15).

CO2 ANALYSIS

As with alcohol, highly significant differences are reported, indicated in Table 2, obtaining values of 2.90 (Vol. CO2) in the beverage with 15% glucose and a value of 0.0 (Vol. CO2) obtained by the beverage with 0% glucose.

When compared with values of Maldonado and Moncayo (2012, p.47) which obtained 2.50 (Vol. CO_2), it indicates that the existing variation in CO2 may possibly be related to soluble solids, reflecting a similarity of concepts with Arias (2013, p.21-22) which tells us, Glucose is the main raw material for yeast growth and carbohydrates are converted to CO2 and C2H6O during fermentation.

In the INEN 1101,2017 Standard, for carbonated or carbonated beverages, it mentions that the permitted ranges for CO2 content are 1-5 Vol.CO Determining that the elaborated product is within these ranges, these being differentiated as the best treatment to 15% of added glucose with a value of 2.5 (Vol. CO_2) since CO2 promotes better preservation, it works as an antioxidant, enhances the flavor and aroma in carbonated beverages.

MICROBOLIGICO ANALYSIS

YEASTS

In the yeast count no statistical differences were reported (<0.05), between the means, indicated in Table 3, despite this a notable difference can be seen in relation to the drink with 0% glucose addition (Highest value), with an average value of 238.00 CFU / ml and 15% glucose addition (Lowest value), with an average value of 171.50 CFU / ml, these results compared with those of Jácome, (2009, p.48), which by adding levels higher than 10% helps the inhibition of yeasts and fermentation, by osmotic stress, in the case of its behavior explains Gomar (201 p.1) saying that at concentrations of 60g / L of glucose is obtained higher speed of yeast growth, while at a concentration of 100 g / L, it is lower.

Table 3. Microbiological analysis of carom soda with different glucose levels.

	Glucose Levels							
Variable	**0%**		**5%**		**10%**		**15%**	
Yeasts ns	238,00	a	227,50	a	227,50	a	171,50	a

One factor contributing to the presence of yeast in beverages is its affinity for glucose, as studies such as Argote's (2015, pp. 42-44) have shown that glucose is the most consumed monosaccharide during fermentation.

SENSORY ANALYSIS

APPEARANCE

The following graph (1) indicates the relationship between glucose levels in the drink and its influence on the appearance of the drink, being the most influenced by the addition of sugar the 15% with an average value of 4.8/5 points (I like it a lot) being an indicator of pleasure in the consumer and being the 0% glucose level that was not influenced, Corroborating what Cuomo indicated, R (2008, p.1) who states that CO2 has a great relationship between the sensory characteristics of soft drinks, since the famous bubbles produce vivacity and effervescence in drinks.

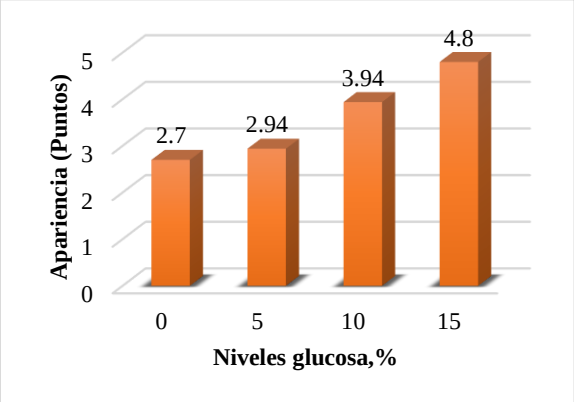

Figure 1. Sensory analysis of the appearance attribute of carom soda.

SMELL

In graph (2) below it could be seen that the influence is repeated in this parameter, being again the drink with 15% glucose levels the most favored in the analysis with an average value of 4.76/5 (I like it a lot) and the drink with 0% glucose addition the least favored with an average value of 2.41/5 points (I dislike it). mentioning that drinks with higher CO2 content tend to have a more pleasant smell, as indicated by Bajaña, (2014, p.50) who mentions that CO2 intensifies the smell in carbonated beverages also possess the characteristic smell of fruit.

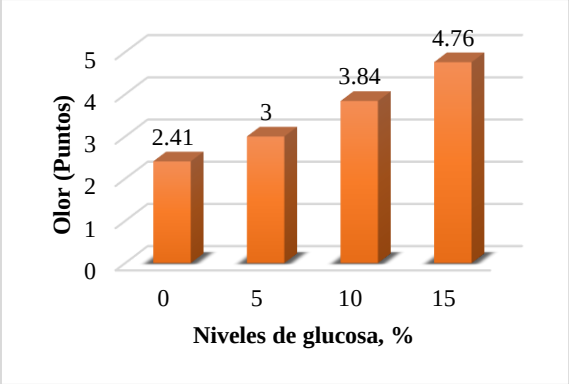

Figure 2. Sensory analysis of the odor attribute of carom soda drink.

TASTE

As well as the previous parameters the influence of the addition of sugar, the greater the amount of sensory characteristics, reporting its highest value of 15% of glucose levels with an average score of 4.78/5 points (I like it a lot), and its lower value of 0% of glucose levels with a score of 2.45/5 points (I dislike it), strengthening the concept given by Gafner, J. (2008, p.1), who mentions that during fermentation, yeasts convert most of the glucose into CO2 and this product makes carbonated drinks, obtain their acid flavor and intensify the flavor, in addition the bubbles produce effervescence in the soft drinks, and the particular sensation they cause to the palate.

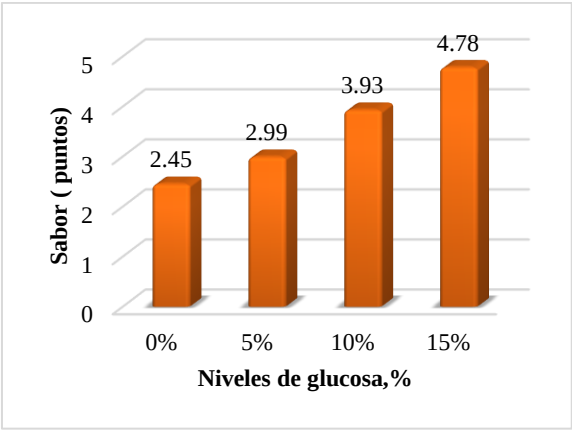

Figure 3. Sensory analysis of the flavor attribute of carom soda drink.

CONCLUSIONS

The results obtained in the yeast count (8.67CFU/g) are within the established by (NTC 404.2007), because fruits are a great contribution of sugars for the development of yeasts, creating optimal conditions for their development.

The values obtained in terms of the physicochemical characteristics of the raw material (Carambola) are found in: pH of 2.50 which categorizes it as a moderately acidic fruit, acidity of 0.62%, soluble solids of 6.87º brix and fermentable sugars of 2.17 g / L

In the product, the pH tended to decrease as glucose levels increased, but soluble solids, alcohol and carbon dioxide increased up to 15% with pH values of 3.68, 12.03, soluble solids, alcohol 1.97 and CO2 2.90, this drink also showed the highest agreement in terms of sensory analysis. The amount of yeast in the soft drink tends to decrease with an inversely proportional relationship to the level of glucose addition, giving us initial values of 238.00 CFU / ml of the control treatment decreases to 171.50 CFU / ml with 15% glucose.

RECOMMENDATIONS

The author recommends the use of percentages of 15% glucose in the preparation of the carom soft drink, since the physicochemical, microbiological and sensory characteristics were excellent and are within the ranges established in the (NTE INEN 1101), also reports greater preference by tasters.

Promote the use of Carambola for the elaboration of different products in the Food Industry, since it is an undervalued fruit, of which there is not enough knowledge of this in the Country, which makes us ignore the benefits that this fruit can offer us not only in the food field but industrial.

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