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CHEMICAL DIFFERENCES BETWEEN HOMEMADE AND COMMERCIAL PINEAPPLE JUICES: A BENIN CITY PERSPECTIVE

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Abstract: This study presents a comparative analysis of the electrical properties and pH levels of homemade and industrial pineapple juice samples across a controlled temperature range, aiming to identify the safer and more desirable option for consumption. Specifically, the electrical conductivity (EC), electrical potential (EP), and pH were measured for each sample from 0 °C to 60 °C at 5 °C intervals. A 150 mL volume of each juice type was tested, with thirteen data points collected per sample.

The homemade juice exhibited EC values ranging from 0.0108 to 0.0357 S/m, EP values between 0.00486 and 0.00923 V, and pH values from 3.20 to 4.60. In contrast, the industrial juice recorded higher EC values (0.0114–0.0784 S/m), slightly broader EP values (0.00472–0.00980 V), and a narrower pH range (3.34–4.10). Statistical analysis using t-tests, correlation, and regression (via EasyStatCalc v1.1.1) indicated a very significant difference ($p < 0.01$) in EC and pH between the two juice types, while EP showed marginal significance ($p < 0.05$).

Results suggest that homemade pineapple juice is generally safer for consumption, primarily due to its higher pH levels, which imply the absence of chemical additives. However, it is not recommended for consumption at 0 °C, as its pH at this temperature falls outside the acceptable safety limit set by the U.S. Food and Drug Administration. These findings provide important insights into the quality and safety of pineapple juice products under varying temperature conditions, with implications for both consumer health and storage practices.

Keywords: Conductivity; Electric Potential; pH; Pineapple Juice.

1.0 INTRODUCTION

Pineapple is the third most important tropical fruit in world after banana and citrus (Bartholomew, Paull and Rohrbach; 2003). The main pineapple-producing countries are Brazil, Thailand, Philippines, Vietnam, Mexico, China, Nigeria, Indonesia, and Columbia (Chen, Shu, Kuan and Tang, 2011). Temperature and relative humidity are the two main factors that affect a pineapple's properties after harvest (Quyen, Joomwong, and Rachtanapun., 2013). Pineapple has excellent medicinal properties, known for centuries in folk medicine. It is extremely rich in vitamin C, and thus has positive effects on protecting the body from free radicals that cause atherosclerosis, bronchitis and heart diseases associated with diabetes, asthmatic attacks, osteoarthritis and rheumatoid arthritis, and damage bowel cells which may lead to cancer. It has a beneficial effect on the proper functioning of the immune system (Coveca, 2002). The benefits of pineapple to humans are enormous; hence, a comparative assessment of some of its electrical properties is essential. The electrical properties herein investigated were electrical conductivity (EC) and electrical potential (EP); then the pH.

The electrical conductivity of foods is of relatively recent interest to researchers. Little literature exists on this, since electrical conductivity was not critical in food applications prior to the late 1980s (Zhang, 2002). The EC of a material represents its ability to transport electric charge, and its measurement provides a direct measurement of ionic behaviour in electrolyte solutions (Kissinger and Heinemann, 1996). EC can also be said to be a rough measure of the relative amount of mineral substances present in the juice (Jambrak, Mason, and Paniwnyk., 2007). It can be influenced by temperature (Palaniappan and Sastry, 1991), electrolyte concentration, chemical content, viscosity, suspended solids, electrolytic strength (Hamann, Hamnett and Vielstich., 1998), and presence of cell structure. A difference in electric potential gives rise to an electric field. Electric field is the force per charge acting on an imaginary test charge at any location in space. The work done by placing an actual charge in an electric field gives the charge electric potential energy. Electrical potential is, therefore, the amount of electric potential energy that a unitary point electric charge would have if located at any point in space, and is equal to the work done by an electric field in carrying a unit of positive charge from infinity to that point (Elert, 2017). Currently, there is no existing literature on EP of pineapple fruit (juice) or any kind of fruit sample. pH value gives a measure of the acidity or alkalinity of a product, while titrable acidity gives a measure of the amount of acid present (Dadzie and Orchard, 1997). Assessment of pH and titratable acidity of pineapples are used primarily to estimate consumption quality. They could be considered as indicators of fruit maturity or ripeness. It also has influence on the flavour

(sweet or sour) of the fruit and to a large extent determines the marketable quality of the fruits (Asare, 2012). The pH balance of the human bloodstream is recognized by all medical physiology text as one of the most important biochemical balances in all of human body chemistry. pH controls the speed of the body's biochemical reactions (Biomedx Group, 2015). Apart from pineapple, the EC and pH of some foods (juices) have been investigated. (Hosain, Mohammad and Gholamhassan, 2013) studied electrical conductivity and pH change during ohmic heating of pomegranate juice while (Lamsal and Jindal, 2014) studied variation in electrical conductivity of selected fruit juices during continuous ohmic heating. More so, (Ahmed, Yousef and Hassan, 2010) investigated the relationship between electrical conductivity, softening and color of Fuerte Avocado fruits during ripening. Thermal and physical properties of some tropical fruits and their juices in Nigeria was studied by Ikegwu and Ekwu (2009) whereas (Adubofuor, Amoah, and Agyekum, 2016) undertook their study on physicochemical properties of pumpkin fruit pulp and sensory evaluation of pumpkin-pineapple juice blends.

Many a time some people used to opt for Industrial (canned) pineapple juice product rather than the homemade (freshly prepared) pineapple juice without any rational behind their choice. Probably they used to prefer Industrial pineapple juice since it is, perhaps, tasteful and handy or already-made. This necessitated our investigation in this study so as to encourage or otherwise discourage and correct such perception. The results were analyzed using ttest, correlation and regression analysis software (EasyStatCalc version 1.1.1)

2.0 Materials and Methods

2.1 Sample preparation

One litre, each of the Industrial pineapple juice (Chivita) and a freshly prepared homemade pineapple juice whose fully matured, ripped and fresh fruit was purchased from Uselu market along Lagos-Benin expressway Benin City, Edo state were provided for the experiment. The analysis was carried out at Elite Environment Consultants and Laboratories (EECL), 188 Uselu Road, Elizabeth Nmoye Plaza, Suit H7-H8, along Lagos- Benin expressway Benin City, Edo state.

2.2 Experimental Procedure

2.3 pH of pineapple juice

The pH meter was calibrated using buffer solutions of pH 4.01, 7.01 and 10.01. The electrical conductivity meter was also calibrated using a standard solution while zero error was corrected for the analogue electrical potential meter before measurements are being taken. A 150 mL of the each sample was used for the analysis in which thirteen measurements were taken for each sample within a temperature range of 0 ^{o}C to 60 ^{o}C at 5 ^{o}C increment. The temperature of the samples was varied using a digital thermostat oven (Model: DHG-9023A, PEC medical USA). It measured between RT + 50 – 200 ^{o}C, with a temperature fluctuation of ±1 ^{o}C.

2.4 Electrical conductivity (EC) of pineapple juice

The electrical conductivity (EC) of the samples was measured using a digital Electrical Conductivity Meter (Model TDS-3). The meter was dipped into the sample up to the maximum immersion level of 2 inches. Air bubbles which could interfere with electric current were eliminated by gently stirring the meter while results were only recorded when the readings were stable. The readings were obtained in micro siemens per centimeter (μS/cm) and then converted to siemens per meter (S/m). Electrical conductivity of the sample showed a linear increment with te

2.5 Electrical potential of pineapple juice

The samples' electrical potential was determined using an analogue electrical potential meter (Model: POT YX360-TR).

2.6 pH of pineapple juice

The pH value of the samples was determined using a digital pH meter (Model: pH-98107). The pH meter had a resolution of 0.1, a typical Electro Magnetic Compatibility (EMC) deviation of ± 0.1 pH and measured at an accuracy of ± 0.1 pH at 20 ^{o}C (68 ^{o}F). Prior to the measurement, the electrode was gently wiped with a cleaning solution (HI 7061M), thereafter, activated by immersing it in a 230 mL storage solution (HI 70300M) for 2 hours.

3.0 Results and Discussion

The EC of the juice samples is shown in Table 1 with values ranging from 0.0108 – 0.0357 S/m for Homemade pineapple juice and 0.0114 – 0.0784 S/m for Industrial pineapple juice respectively. Analysis of the EC of both samples revealed that they were highly positively correlated with temperature, increasing steadily but slightly from 0 ^{0}C – 30 ^{0}C, then abruptly from 35 ^{0}C – 60 ^{0}C (Fig. 1). This result is consistent with the work of (Barron and Ashton, 2007) which reported that an increase in the solution's temperature will lead to an increase in its conductivity. The result of Table 2 showed that the EC of the Industrial pineapple juice was very significantly higher at power value ($p < 0.01$) than that of the Homemade pineapple juice with the former having a Mean±SEM EC of 0.025±0.006 S/m as opposed to the latter which had 0.018±0.002 S/m as shown Table 3. The very significantly higher EC of the Industrial pineapple juice than the EC of the homemade pineapple juice might not be unconnected to the additives blended into the former.

Table 1. Summary of results of electrical properties and pH of Homemade and Industrial pineapple juice samples.

T (⁰C)	0	5	10	15	20	25	30	35	40	45	50	55	60
		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
EC_h(S/m)	0.01												
	08	13	15	16	17	21	22	57	70	20	52	16	
		57											
EC_i(S/m)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.07	0.07
	14	18	20	22	24	25	26	76	85	34	02	53	
		84											
EP_h(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	923	751	517	548	636	486	721	706	862	840	782	624	649
EP_i(V)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	980	761	548	520	500	640	680	472	526	763	724	686	674
pH_h	4.60	3.90	3.70	3.63	3.60	3.54	3.52	3.50	3.44	3.43	3.42	3.30	3.20
pH_i	4.10	3.50	3.44	3.43	3.42	3.41	3.39	3.38	3.37	3.36	3.36	3.35	3.34

EC_h, pH_h and EP_h are the EC, pH and EP of Homemade pineapple juice while EC_i, pH_i and EP_i are the EC, pH and EP of Industrial pineapple juice.

It could be seen from Tables 2 and 4 that the EP of the Homemade pineapple juice was significantly higher ($p<0.05$) than the Industrial pineapple juice with Mean±SEM values corresponding to 0.006957692±3.76E-4 and 0.0065184617±3.92E-4 respectively (Table 3). However, while Table 2 showed that the EP of the two juice samples were poorly positively correlated, Table 4 showed that there was no correlation and indeed no linear relationship between the EPs of both juice samples and their corresponding temperatures as also evident in Fig. 2. Also, Table 4 revealed that there was no significant difference ($p<0.05$) between the EPs of both juice samples and temperature.

Table 2. Correlation, regression and t-test of EC, EP and pH.

	EC_h versus EC_i	**EP_h versus EP_i**	**pH_h versus pH_i**
r	0.959897	0.553317	0.935407
R^2	0.921403	0.306160	0.874987
t_o	11.355816	2.203133	8.774445
P	0.000000 ** (2 tail)	0.049813 * (2 tail)	0.000003 ** (2 tail)

r = [Correlation coefficient], R^2 = Coefficient of determination, p = p value (2 tail, *$p < 0.05$, **$p < 0.01$). EC_h, pH_h and EP_h are the EC, pH and EP of Homemade pineapple juice while EC_i, pH_i and EP_i are the EC, pH and EP of Industrial pineapple juice.

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Table 3. Evaluation of electrical properties and pH of Homemade and Industrial pineapple juice samples.

	Mean±SEM	Std Dev	Sample Variance	Minimum	Maximu m	Range
EC_h	0.018±0.002	0.008124264	5.557E-4	0.0108	0.0357	0.0249
EC_i	0.025±0.006	0.0226482	7.150E-5	0.0114	0.0784	0.0670
EP_h	0.007±3.76E-4	0.0013009	1.9929807E-6	0.00486	0.00923	0.00437
EP_i	0.007±3.92E-4	0.0013563461	1.8333692E-6	0.00472	0.00980	0.00508
pH_h	3.598±0.097	0.33486727	0.12148077	3.2	4.6	1.4
pH_i	3.450±0.056	0.19239382	0.0401	3.34	4.1	0.76

EC_h, pH_h and EP_h are the EC, pH and EP of Homemade pineapple juice while EC_i, pH_i and EP_i are the EC pH and EP of Industrial pineapple juice, SEM=Standard Error of the Mean, Std Dev=Standard Deviation

Table 4. Correlation, regression and t-test of Ep_h and EP_i with temperature.

	EP_h versus T	**EP_i versus T**
r	0.051993	0.135506
R_2	0.002703	0.018362
t_o	0.172675	0.453608
P	0.866043 NS (2 tail)	0.658930 NS (2 tail)

r = [Correlation coefficient], R^2 = Coefficient of determination, p = p value (2 tail, $*p < 0.05$,$**p < 0.01$). EP_h and EP_i are EP of Homemade and Industrial pineapple juice samples respectively, T = temperature.

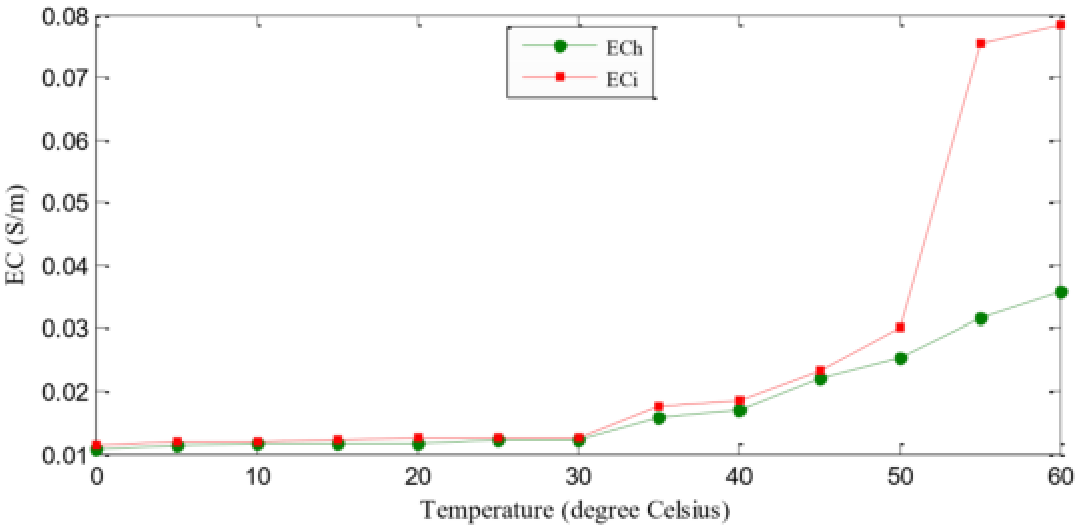

Figure 1. EC of Homemade and Industrial pineapple juice samples versus temperature

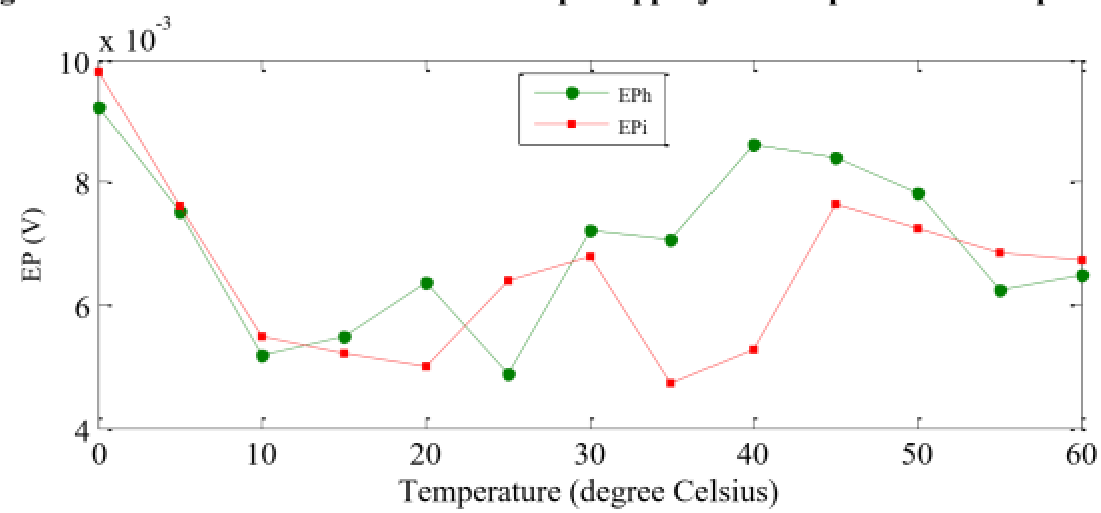

Figure 2. EP of Homemade and Industrial pineapple juice samples versus temperature

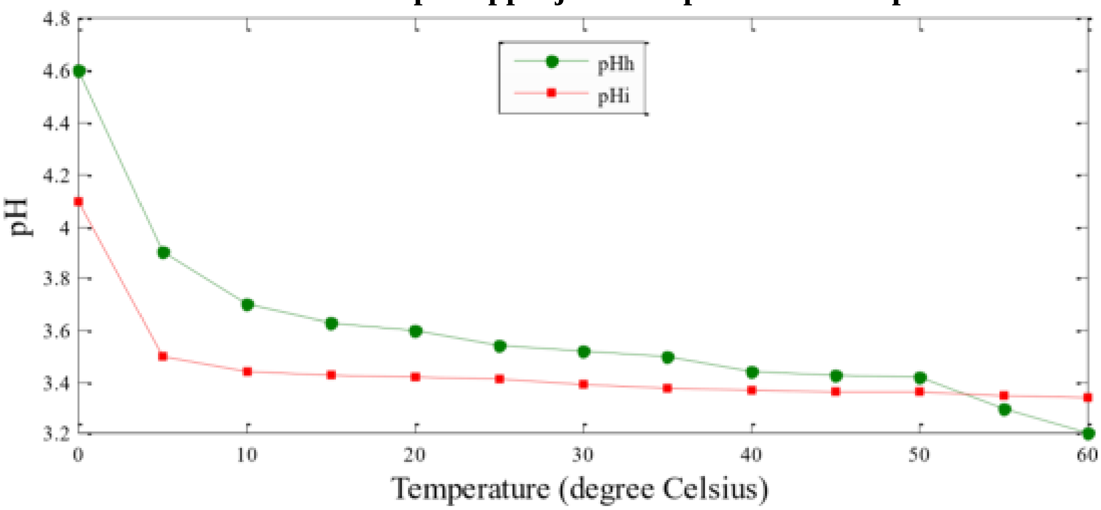

Figure 3. pH of Homemade and Industrial pineapple juice samples versus temperature It is evident from Table 1 that the pH of both products decreased with increasing temperature having values ranging from (3.20 – 4.60) for Homemade pineapple juice and (3.34 – 4.10) for Industrial pineapple juice respectively (Fig. 1). This is supported by the U.S Food and Drug Administration Centre for Food Safety and Applied Nutrition (2000) and U.S Food and Drugs Authority CFSAN (2007) which stated that the pH value of pineapple juice should range from

3.20 – 4.00 for Homemade and 3.35 – 4.10 for Industrial (canned) pineapple juice (see Appendix A). The values were comparable to the range (3.98 - 4.21) stated by Awsi and Er.Dorcus (2012). However, (Erston, 1950) in his work obtained the range of pH values of five different varieties of pineapple juice at 0 ^oC and 25 ^oC as (3.51 – 3.81) and (3.46 – 3.60) respectively, as against (3.54 – 4.6) and (3.41 – 4.1) recorded in this work for Homemade and Industrial pineapple juices at the same temperatures. Although considerable variation exists between pH of pineapple varieties, condition of growing and processing methods could influence the pH levels (Hamann *et al*; 1998). We observe from Fig. 3 that there is an initial pH gap of 0.5 between the Homemade and Industrial pineapple juices which diminishes gradually and finally overlaps at 52 ^0C corresponding to pH of 3.4. The result of Table 2 showed that there was a very high significant difference ($p<0.01$) between the pH of the two samples. The Industrial pineapple juice having a lower mean value (3.450) was more acidic than the homemade pineapple juice with a mean value (3.598). The pH values obtained reflects to a significant extent the microbial stability of the various varieties [samples], (Asare, 2012). Additives are added to canned pineapple juice to reduce its pH and enhance its shelf life.

The activity of sorbic acid [acidifier] increases as the pH decreases (Food and Agricultural Organization of the United Nations, 2016). One of the principal techniques used by the food industry to combat microbial proliferation in juice is raising its acidity by lowering its pH with additives (Commission of the European Communities, 1980). Not all of these additives are 100-percent safe for everyone, some preservatives are associated with adverse effects, which can involve an unpleasant reaction in people sensitive to a particular additive or a potential increased risk for cancer, rashes, low blood pressure, diarrhea, flushing, abdominal pain, asthmatic reactions and anaphylactic shock (Bruso, 2015).

4.0 Conclusion

This study revealed that the electrical properties and pH of Homemade and Industrial pineapple juices are very highly significantly different. Moreover, the study showed that for optimum balance of the body's pH, homemade pineapple juice should not be taken when chilled at 0 ^0C since the pH value (4.60) at this temperature exceeds U.S Food and Drugs Authority CFSAN (2007) recommendation. Some food additives used for preserving Industrial pineapple juice were essentially responsible of its low pH (high acidity). These additives can potentially cause harmful side effects; therefore, fresh natural homemade pineapple juice is safer for consumption than industrially processed pineapple juice.

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