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Kinetic Studies of the Total Acidity and Comparative Studies of Some Parameters in Artificial Ripened Fruits

[1]S.O. Okeniyi, [2]P.A. Egwaikhide, [3]E.E. Akporhonor and [4]S.A. Emua
[1]Department of Chemistry, Nigerian Defence Academy, Kaduna, Nigeria
[2]Department of Chemistry and Centre for Biomaterials Research, University of Benin, Nigeria
[3]Department of Chemistry, Delta State University, Abraka, Nigeria
[4]Department of Botany, Ambrose Alli University, Ekpoma, Nigeria

Abstract: Comparative analysis of the acetylene induced ripened and naturally ripened mango and banana fruits were studied. The Kinetic studies on the rate of decrease in total acidity were also investigated. The vitamin C contents of induced mango and banana fruits were 25.50 and 25.09 mg $100g^{-1}$, respectively while naturally ripened mango and banana fruits were 24.53 and 24.40 mg $100g^{-1}$. The total percentage sugar in induced mango and banana fruits were 22.06 and 21.06%, while naturally ripened mango and banana were 21.06 and 20.63%, respectively. The vitamin C (ascorbic acid) content and total percentage sugar data were higher than the naturally ripened fruits. The Kinetic studies of the rate of decrease of the total acidity gave a first order rate constant (K) for mango and banana juice as $1.5\times10^{-2}h^{-1}$ and $1.2+10^{-2}h^{-1}$, respectively while the $t_{1/2}$ ranged 57.75-46.20 and 69.30-57.75 h for the induced mango and banana fruits. There was a sharp decrease in the total acidity of the induced fruits against the naturally ripened ones.

Key words: Kinetic studies, mango, banana, acetylene, induced ripening, vitamin C, total percentage sugar, total acidity

INTRODUCTION

Investigating the rates, at which changes occur in a particular system and the forces that influence such rate are known as kinetic studies. These are important in providing information that gives an insight into the mechanism of the change involved and allows prediction of the degree of change that will occur after a time has elapsed. The application of knowledge derived from fruit and chemical kinetics studies provide a more rational approach to be made towards the ripening of fruit using acetylene generated from calcium carbide (Willey, 2002).

Until now a healthy diet has always been supplemented with the best of local fruits such as mango, banana, pawpaw, plantain, pineapple and avocado. These are so tempting when they are ripe. What most of us do not know is that these fruits can severely affect our health. When you sometimes pay twice as much for a golden fruit and it still taste watery, it could be possible that it has been treated with acetylene. Don't fault the fruits for this, this blame lies with unscrupulous traders, who in a hurry to earn quick money, are resulting to quick-fire but potentially poisonous method to ripen fruits in one to two days. The fast ripening of fruits means they imbibe various harmful properties.

The commonly used agent in the ripening process is calcium carbide, a material more commonly used for welding purposes. The carbide treatment is extremely hazardous because it contains traces of arsenic and phosphorous. Once dissolved in water, the carbide produces acetylene gas is an analogue of the natural ripening agents produced by fruits known as ethylene. Acetylene irritates the ethylene and quickens the ripening process.

In some cases, it is only the skin that changes colour, while the fruit itself remains green and raw. When the carbide is used on very raw fruit, the amount of the chemical needed to ripen the fruit has to be increased. This results, in the fruit becoming even more tasteless, heaty and possibly toxic.

Early symptoms of arsenic and phosphorous poisoning include vomiting, diarrhoea with or without blood, burning sensation of the chest and abdomen, thirst, weakness, difficulty in swallowing and speech and garlic like odour of breath, numbness of the legs and hands general weakness, cold and damp skin and low blood pressure.

The process of fruit ripening is chiefly regulated by a gaseous plant hormone called ethylene. Ethylene is a natural plant hormone which effects the growth,

Corresponding Author: S.O. Okeniyi, Department of Chemistry, Nigerian Defence Academy, Kaduna, Nigeria

development, ripening and senescence (ageing) of all plants. It is normally produced in small quantities by most fruits. Many fruits produce larger quantities of ethylene and respond with uniform ripening when exposed to an external source of ethylene. Most fruits have elevated ethylene levels during ripening and sometimes just a peak in ethylene levels before the process of ripening begins (Hulme, 1986; Leitch, 1984).

Fruit ripening is usually defined as the process between the onset of the climacteric in respiration and the stage when the fruit has the normal colour and texture at which it is consumed. The beginning of climacteric normally takes place between the time the fruit is fully matured and the stage at which the fruit is half orange in colour (Leitch, 1984).

Ripeness is the optimum or peak condition of flavour and colour and texture for a particular fruit (Peters, 2003). Fruit ripening clearly involve the induction and acceleration of a variety of metabolic reactions, presumably most or all enzymatic ally catalyzed. There are two general concepts about how this comes about. In the fruit, ripening is seen to result from a progressive increase in cell permeability leading to increased contact between enzymes and substrates already present in a different process, secondly, under genetic control involving the programmed synthesis of specific enzymes required for ripening (Michael, 1979).

MATERIALS AND METHODS

The unripe mangoes and banana were purchased from Ihievbe Market, Edo State. The fruits were already at the peak of maturity prior to set off climacteric period. All other materials were used as supplied.

Processing of juice: The exocarps of the fruits were peeled and the mesocarp blended using a blender and dissolved in distilled water to make sample solution of known concentrations. The sample solutions were prepared for chemical analysis.

Chemical analysis of the juice: The analysis of the resulting juice from the treated fruits was carried out at interval of 6 h, according to.

Determination of specific gravity: The specific gravity bottle was washed, cleaned and dried in an oven and cooled inside desiccators. It was weighed to a constant weight using a weighing balance and then filled with fruit juice and weighed, the weights were recorded. The same procedure was repeated with distilled water.

$$\text{Specific gravity} = \frac{\text{Weight of the sample}}{\text{Weight of equal volume of water}}$$

PH determination: The pH of the juice was determined by using coining Model 240 pH meter.

Determination of total acidity: Five milliliter of the fruit juice was added to 75 mL of boiled distilled water and the solution was titrated against 0.1M sodium hydroxide solution already prepared using phenolphthalein as indicator.

The total acidity obtained is expressed as % acetic acid per 100 mL of the juice using the equation.

$$\text{Total acidity 100 mL}^{-1}\text{ juice} = \frac{VN_aOH \times MN_aOH \times 75 \times 100}{100 \times V\text{sample}}$$

Determination of total sugar: The quantitative determination of sugar requires a suitable solvent (95% ethanol) first to extract sugars from juice (Kalenga *et al*., 1981). Sugars extracted with solvent are directly analyzed to determine the sugar content (Dubois *et al*., 1956).

Determination of vitamin C: Juice sample were analyzed for ascorbic acid using the Harvest-plus sampling. Method (Delia *et al*., 2004; FAO, 1986).

$$\text{Ascorbic acid 100 g}^{-1} = \frac{X - B \times F \times V \times 100}{E \times Y}$$

Where,

X = Average volume mL for test titration
B = Average mL for test blank titration
F = mg ascorbic acid equivalent to 1.0 mL dichloride indophenols standard solution.
E = Weight of sample
V = Volume of initial test solution
Y = Volume of test solution titrated

Parameters such as ascorbic acid content, percentage total sugar content, total acidity content, pH and specific gravity were monitored for the acetylene induced and naturally ripened banana and mango fruit juice every 6 h for 3 days as shown in Table 1.

Kinetic studies of total acidity of the sample: First order reaction kinetics was assumed and carried out on both the banana and mango juice (Table 2). Total acidity content using first order equation (Stocchi, 1990).

$$\text{In}\frac{a}{a-x} = kt \qquad (4)$$

Table 1: Ascorbic acid content, percentage total sugar content, total acidity content, pH and specific gravity in banana and mango juice

Time (h)	Ascorbic acid (Vitamin C) mg $100g^{-1}$		Percentage total sugar (%)		Total acidity (cm^3)		pH		Specific gravity $\times 10^{-4}$	
	Banana	Mango	Banana	Mango	Banana	Mango	Banana	Mango	Banana	Mango
0	21.63	23.83	19.20	18.95	10.80	21.00	5.45	4.35	10.08	10.19
6	22.10	24.10	19.60	19.35	10.00	19.48	5.50	4.50	10.10	10.20
12	22.60	24.35	19.90	19.85	9.40	17.60	5.60	4.68	10.18	10.23
18	23.10	24.60	20.30	20.30	8.80	16.00	5.70	4.80	10.20	10.25
24	23.60	24.85	20.16	20.70	8.00	14.40	5.80	4.95	10.25	10.28
36	24.08	25.04	20.95	21.20	7.80	12.60	5.88	5.10	10.30	10.30
48	24.56	25.30	21.30	21.60	6.70	10.80	5.98	5.25	10.32	10.31
72	25.06	25.50	21.68	22.06	6.00	9.00	6.01	5.42	10.38	10.32
Natural ripening	24.40	24.53	20.65	21.45	7.00	18.00	5.34	4.98	10.31	10.24

Table 2: Rate constant (K) of banana and mango juice

Time (h)	Rate Constant (K) $time^{-1}$	
	Banana Juice	Mango Juice
0	1.1×10^{-2}	1.3×10^{-2}
6	1.1×10^{-2}	1.4×10^{-2}
12	1.1×10^{-2}	1.5×10^{-2}
18	1.1×10^{-2}	1.5×10^{-2}
24	1.1×10^{-2}	1.5×10^{-2}
36	0.9×10^{-2}	1.5×10^{-2}
48	0.9×10^{-2}	1.4×10^{-2}
72	0.8×10^{-2}	1.2×10^{-2}

$$K = \frac{2.303}{t} \log \frac{a}{a-x} \quad (5)$$

$$\text{Half Life } \frac{t1/2=0.693}{K} \quad (6)$$

Analysis on the ascorbic acid, total sugar, pH and specific gravity was carried out on unripe banana and mango fruit, which's ripening was induced by calcium carbide. The analysis was carried out at 6 h interval until the fruits got ripened on the third day. When compared with naturally ripened fruit the result of the experimental investigation showed that the above mentioned parameters are higher in calcium carbide induced ripened fruits than naturally ripened fruits.

The total acidity content of banana and mango fruit showed a decrease in level with increase in time for calcium carbide induced ripened fruits. The total acidity of calcium carbide induced ripened banana (6.70 cm^{-1}) fruit is less 700 cm banana, after 48 h than naturally ripened banana (7.00 cm^3) and also the calcium carbide induced ripened mango (17.60 cm^{-3}) fruit is less thank naturally ripened mango (18.00 cm^{-3}) after 12 h (Rehmm and Reed, 1996).

According to Hulme (1996), the total acidity falls during ripening from pre-climacteric to post climacteric peak. The total acid generally decreases during ripening. The acid content of the fruits changes with maturity and affects flavour.

The kinetic studies of the total acidity showed that for both Banana and mango fruit, the rate constant (k) was first order throughout.

CONCLUSION

Close scrutiny when buying fruits can make it possible to identify fruits that have been treated with carbide. When tomatoes, are uniformly red or mangoes, bananas, papaws are uniformly orange, one could easily make out that carbide may have been used. Plantain can also be identified if the stem is dark green while the fruits are all yellow. However, those who consume local fruits on an almost daily basis may have to think twice before they bite into that ripe mango, banana or plantain as rather than keeping the doctor away its likely you would need to rush to your doctor. While most cases of arsenic and phosphorous poisoning are detected before they become fatal. If not treated in time, these can prove fatal. Traders should be discourage from using this method of fruit ripening.

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