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Production and Preservation Techniques for Orange, Pineapple and Apple Fruit Juice Samples

Ukpai Chima Allen[1], Ajakaye Adebayo Solomon[2], Ugwueze Ogochukwu Stella[3], Imadu Respect Olutayo[4], Effiong Eyo John[5]

[1]Plastic Recycling unit, Scientific Equipment development Institute (SEDI,Enugu,Nigeria
[2]Manufacturing Sevices Unit, Prototype Engineering Equipment Development Instiute, Ilesa, Osun State, Nigeria
[3]Electroplating Unit Scientific Equipment Development Institute (SEDI) Enugu, Nigeria
[4]Maintenance unit, National Agency for Science and Engineering Infrastructure (NASENI) Abuja, Nigeria
[5]Plastic Recycling Unit, Scientific Equipment Development Institute (SEDI) Enugu, Nigeria

Abstract Juice were produced from orange, apple, pineapple and a mixture of the three fruit samples. They were preserved using different methods of preservation for four weeks. The physico-chemical parameters of the juices was investigated. Juice was extracted from the fruit samples and pasteurized for four minutes at 65 °C. The juice concentrate was then divided into seven subsets A, B, C, D, E, F, and G and were then preserved with different techniques of juice preservation for purpose of comparison. The analysis examined some parameters such as conductivity, turbidity, vitamin C, salinity, pH, titratable acidity, total sugar, brix value etc.
It was found out that the vitamin C and some important physico-chemical parameters were higher in orange juice than that of apple and pineapple juice. Conclusively, highest shelf life was obtained from the most effective technique of fruit juice preservation that is the subset G.

Keywords Fruit juice, Preservation, Extraction, Pasteurization, Apple, Orange and Apple

Introduction

Origin of Fruit Juices

The production of fruit juices from fruits is as old as agriculture. On ripening most fruits soften to the point where simply handling them could yield more juices than flesh, although partially fermented. The resulting pulp fluid easily separated from seed and skin is generally more flavourful than the more solid portion (FAO, 2008).
Through trial and error humans learnt practical ways of extracting juice from various sources and most importantly which attractive but toxic fruits to avoid. Tool making skills fostered the manufacture of devices for macerating fruits and extracting juices. Natural chilling and freezing was the only alternative to microbial modification of the juice with respect to its perishable nature. Thus juice was found to be bubbling after mysteriously having a distinctly different character on those consuming the product [1].

Definition of Fruit Juices

Generally, juices refer to the fluid expressed from plant material by crushing, commuting and pressing. However, many fruits juices are often the result of expressing the liquids from the cut or whole fruit. Consequently, Michael

[2] defined juice as unfermented but fermentable juice, intended for direct consumption, obtained by the mechanical process sound, ripe fruits preserved exclusively by physical means. Thus it could be turbid or clear.

Types of Fruit Juices

The different types of fruit juices are:

Citrus juice – grape fruit (citrus paradise), sweet orange (*Citrus sinensis*), tangerine (*Citrus reticulata*), lime (*Citrus quaratifilia*)

Grape juice

Tree fruit juice - apple, pear, peach plum, apricot

Berries – potent colour makes it ideal for blending. Example include, combery, blue beery and certain grape species, such as vifia labruca rotundafilis and aestavalis.

The Technology of Juice Extraction and Processing

The extraction of juices involves the squeezing of the fruits to obtain liquid slurry, which comprises the juices residue and filtrates. Thus the essence of juice processing is to minimize the undesirable reactions while still maintaining, and in some cases enhancing the inherent quality of the starting fruit [3].

Quality Assurance and Control

The use of non-food grade equipment in the processing line is a relatively minor safety concern that still impacts on juice quality, physical changes can also take their toll on juices quality. Unit operations such as cooling and cleaning involved in the processing of juices constitute the physical removal of surface debris by brushes or air jet separation prior to washing with water. These steps substantially decrease water use and speed up product flow enhancing better quality of juices [3].

The Nutritional Importance of Fruit Juices

The consumption of fruit juice substantially increases the quantity of vitamins, mineral salts in human body system. In addition to the nutritive value of juices and additional health benefits from phytochemicals, recently recognized components of many fruit juices helps to balance diet, which otherwise sustains the growth of human life.

The Chemistry1 of Fruit Juices

Even barring microbial and enzymatic changes, other chemical reactions involving oxygen, metal cations and other juice constituents can occur to modify sensitive pigment, taste or aroma. There are literally hundreds of reactive compound in the simplest of juices, so the reaction possibilities are enormous [4].

The Microbial Aspect of Fruit Juice

Sound fruits, reasonably free from microbial contaminants are subject to biochemical deterioration upon juicing. The mixing of fruit enzymes with substrate and air can rapidly initiates enzymatic browning. Plant phenols, polyphenol oxidase and oxygen react to darken many juices. So rapid processing, and the use of heat or enzyme inhibitors are necessary with some juices [5].

Experimental

Materials and Equipment's Used

Materials Used

Materials used were:

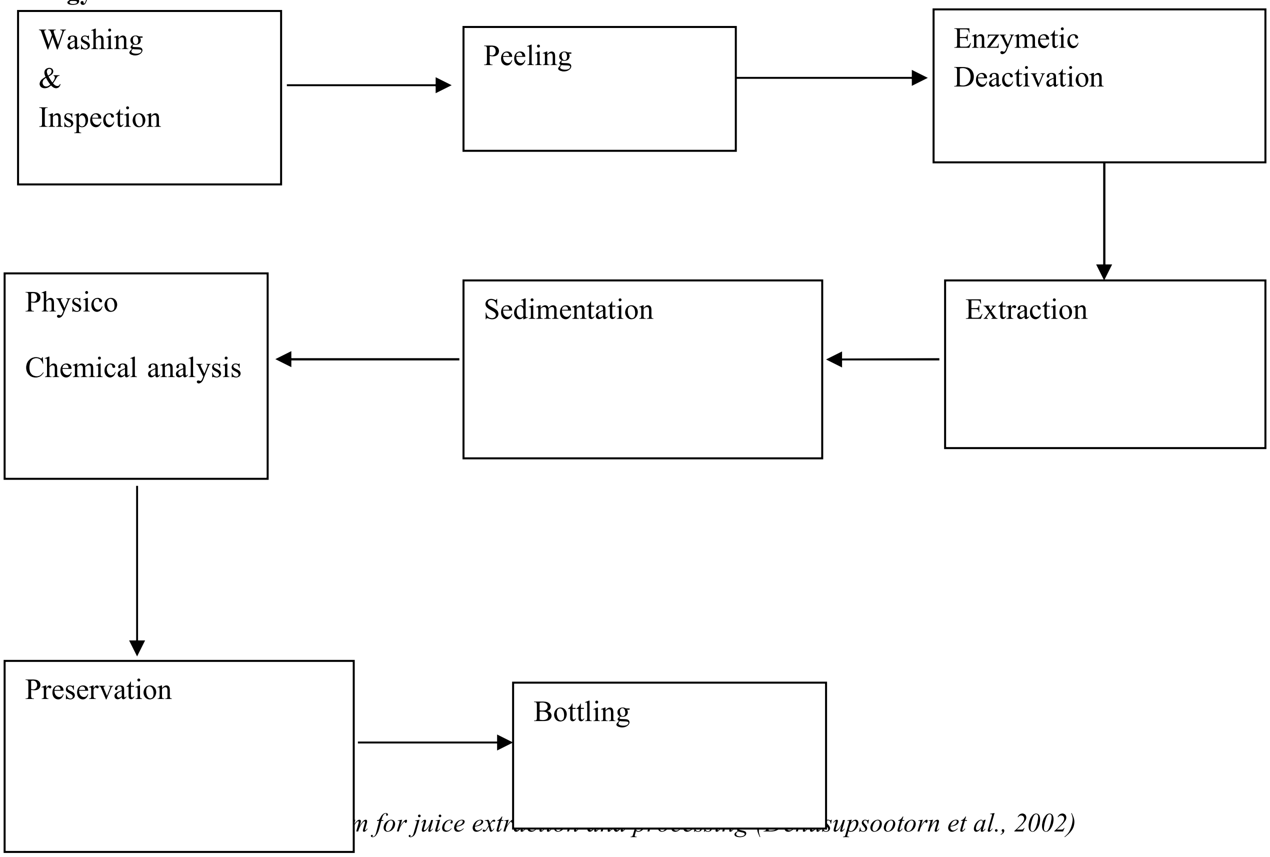
Orange, pineapple, and apple fruit samples.

Equipment's Used

Items of equipment used were:

Measuring cylinders, (1L, 500ml, 250ml, 100ml); Dispensing bottles, test tubes, magnetic stirrer, water bath, knife, porcelain crucible, weighing balance, triple beam balance, glass desiccators wire, silica gel, juice extractor, pH meter, Hack multi-tester, c150 for total dissolved solids, conductivity, salinity temperature measurement, laboratory oven size IV, complex set of retort stand with clamp. Volumetric glassware, auto clave prestige table top British, Hand gloves, Nose mask, laboratory coat, sacharometer, secchi dish and hot plate**.**

Methodology



n for juice extr… upsootorn et al., 2002)

Sample Treatment and Aseptic Conditions

Aseptic conditions were observed by washing the work bench with soap in water solution, the glass wares, extractor, bowl, window louvers all rinsed with tap water after washing in soap solution. However, a disinfectant was used to scrub the equipments and facilities in the laboratory. All the glassware, dispensing bottles were autoclaved at 121 ^{o}C for 15 minutes and kept dried in an oven at a temperature of 50 ^{o}C until they were needed for use. Prior to the processing of the fruits for juicing, the necessary dressing code was adequately followed.

Procedures Used

The fruits were thoroughly washed and peeled. The orange fruits were cut into smaller bits while the pineapples were transversely cut to remove the peduncle and later cut into smaller bits. The same treatment was given to the apple fruit, after which it was treated with warm water of 60^{o}C temperature for 10 minutes in order to deactivate enzymatic activities.

Subsequently, the cut fruit were fed into the extractor continuously for extraction of the juice, and on extraction separation was at the same time down on the juice extractor.

Extraction Steps

The juice extractor consists of a pusher, feed tubule grating sieve, grating sieve holder, stainless bowl with spout, and derive spindle, pulp container and soft button switches. The parts were washed in soap solution and rinsed with cold tap water first and latter with hot water.

The parts were correctly assembled and the extractor plugged into the power socket and switched on. A transparent jug was used in collecting the juice extracted, as the cut fruit were continuously fed into the feed tubule and pushed down gradually with the pusher. The volume of extracted juice was measured as well as the weight and finally subject to preservation techniques after carrying out a physico-chemical analysis on extraction.

Physico- Chemical Analysis

Prior to preservation, the samples of the juice extracted from each fruit was subjected to physic-chemical analysis with the following physical and chemical parameters measured as described by AOAC, [6].

The physical parameters measured were:

Conductivity

The conductivity was determined using Haach C150 conductivity meter programmed to measure conductivity, salinity, turbidity and total dissolved solids. The instrument was calibrated prior to usage. 5ml of the juice sample was used in each case. The prose/electrode of the instrument was dipped into a test tube containing 5ml of the test juice sample and the operation button pressed. The value was displayed at the liquid crystal display panel. This was taken as the true value of the conductivity.

The essence of testing for conductivity was to determine the presence of ions present in the juice sample; hence conductivity was measured in the micro scimion (μSm^{-1}).

Salinity

This refers to the measure of the amount of dissolved salt in the sample juice and it is aimed at determining the presence of either sodium ion (Na^+) or potassium ion (K^+) in the juice sample.

The same technique as in testing for conductivity was followed, but in this case the salinity mode was set out from the program and the value of the salinity in percentage displayed in the liquid crystal display panel.

Turbidity

This is the measure of food susceptibility. It could be also referred to as the measure of suspended material in the juice sample caused by the presence of dissolved salts and debris. The Direct Reading Engineering Method measured it with the turbidity mode set out from the program and the value of turbidity recorded.

Total dissolved solids

With the probe still immersed in the juice sample, the total dissolved solids mode was set up and its value in milligram per litre (mg/l) displayed at the liquid crystal display panel.

Sensory Evaluation

The sensory evaluation of taste and colour was determined by the panel method during which fifteen students of the faculty of pharmaceutical sciences of the University of Nigeria Nsukka and five members of the project group were used. The test parameters of okay, bitter, sour taste, were used and the average response taken as the time response. However the same people were used throughout the study.

Colour

The colour content with ascorbic acid in the juice sample with the intensity of the colour absorbing monochromatic light at a wavelength of 540nm directly proportional to the concentration of juice.

Moisture content

A porcelain crucible of constant weight w_1 was used. A sample of fruit juice was introduced and its new weight w_2 noted. The crucible with its content was heated using an oven at a temperature of 65°C for 3hr, cooled in a desiccator and reweighed. Subsequently heating cooling was continued at intervals of 1hr until a constant weight w_3 obtained.

The percentage moisture content was calculated from the relationship;

$$\% \text{ Moisture content} = \frac{w_2 - w_1}{w_2 - w_3} \times 100$$

Ash content

A crucible of known weight w_1 was used. 3.0g of the juice sample accurately weighed into the crucible and heated in an oven at 65^o C to demoisturize it for 3hr, and then in a muffle furnace at 650^o C for about 5hr until all the organic component were completely burnt away leaving a greyish white ash residue. The crucible with the ash residue and its weight w_3 noted.

The percentage ash content was calculated from the relationship:

$$\% \text{ Ash content} = \frac{w_2 - w_3 \times 100}{3}$$

Appearance

Separation of dispersed particles could help or hinder appearance as physical changes can also take their toll on juice quality. Clear juice can turn cloudy or release an unsightly precipitate. Thus, chemically or freeze thaw induced colloidal reactions can affect juice viscosity to thicken or thin consistency and influence the taste.

Similarly the chemical parameters measured include the following:

Vitamin C

This is a water soluble mineral, which acts like an oxidant, thus high level of vitamin C ensures more stability of the juice extracted. The decrease of vitamin c implies food spoilage.

pH

This is the negative logarithm to base 10 of the hydrogen ion (H^+) concentration. The pH of a solution has a great influence on the viscosity of enzyme catalyzed reaction due to the effect on the active sites of the enzyme. It also affects the stability of an enzyme and this must be taken into account in any study of the effect of pH on substrate binding and catalysis. It is measured with the pH meter set out from the program and the value of the pH displayed in the liquid crystal display panel.

Reducing sugar

This deals with the sugar content of the juice sample and can be tested using the direct reading engineering method.

Total sugar

This is determined by the cleg antrum colorimetric method. Thus, the antrum reagent is a die that forms a chemical colour complex with the sugar, the absorbance of which is measured in a colorimeter.

Titratable acidity

This is determined by the titrametric method using phenolphthalein indictor.

Microbial Analysis

Microbial load was determined in the raw juice prior to preservation and subsequently for 1month at 8days interval. The physico-chemical parameters were done periodically as stated above for 40days. The values obtained on extraction were compared to that obtained after preservation and used as a measure of efficacy. The change in values per time was also used to determine the half-life of the juice, which is invariably the shelf-life as described by Delia *et al.*, [7] and Steven and Bajer, [8].

Preservation

8 liters of orange juice, pineapple juice, and apple juice were extracted respectively. 333.3ml of each juice were carefully measured using a measuring cylinder into a 1liter preheated dispensing bottle having a screw cap and the mixture vigorously shaken.

Seven sets of 1liter each of the juice mixture were measured into a dispensing bottle and labelled M_1, M_2, M_3, M_4, M_5, M_6, M_7. Three sets of 1liter each of the orange pineapple and apple juice sample was measured into another sterilized dispensing bottle carefully, so that there was a set of three 1liter bottle of each fruit juice labelled O_1, O_2, O_3; P_1, P_2, P_3, and A_1, A_2, A_3 representing orange pure juice, pineapple pure juice and apple pure juice respectively.
Another three set of 1liter each of the orange pure juice, pineapple pure juice, apple pure juice labelled O_x, O_y, O_z, P_x, P_y, P_z, and A_x, A_y, A_z respectively were measured into a sterilized dispensing bottle. A set of 1liter each of the orange pure juice, pineapple pure juice and apple pure juice were measured into another sterilized dispensing labelled O, P and A respectively such that:
$M_1O_1P_1A_1$ was considered a subset of A
$M_2O_2P_2A_2$ was considered a subset of B
$M_3O_3P_3A_3$was considered a subset of C
$M_4O_xP_x$ A_x was considered a subset of D
$M_5O_yP_yA_y$ was considered a subset of E
$M_6O_zP_zA_z$ was considered a subset of F
M_7OPA was considered a subset of G
Each element of subset A was preserved with 3.50mg/kg of sodium metabisulphate
Each element of subset B was preserved with a 3.50mg/kg of sodium benzoate
Each element of subset C was preserved with a mixture of 1.75mg/kg of sodium metabisulphate and 1.75mg/kg of sodium benzoate make up for the 3.50mg/kg of the weight of the preservative for every 1000ml of the juice.
Each element of subset D was preserved physical method using an ultraviolet irradiation at an exposure period of 1hr.
Each element of subset E was preserved by physical method using a combination of ultrasonication and ultraviolet irradiation.
Each element of subset F was kept as control experiment without any preservative except the general pasteurization applied to all the subset.
Each element of subset G was preserved using all the preservatives mentioned above.
All the sets were kept at the same temperature and pressure condition (room temperature and pressure) for 1month. Aseptically, 20ml was collected from each juice sample for physical, chemical and microbial parameters. The values obtained were compared with values obtained immediately after extraction (before addition of preservatives) and any change in the values per time noted. Hence the values were used to determine the shelf life.

Results and Discussion

Table 1: Physico-chemical and microbial analysis of raw fruit juice on pre-preservation.

Sample code	**Parameters**										
	pH	**M**	**Tu**	**Tds**	**Con**	**Sal**	**Ta**	**Ts**	**Vc**	**Bl**	**Br**
On	4.7	82.2	0.73	1.93	3.79	2.0	3.80	18.45	250.6	12	10.1
Pn	4.5	79.2	0.75	1.12	2.29	1.2	3.70	17.11	208.4	15	11.5
An	4.6	77.5	0.89	1.02	2.05	1.3	3.95	2.20	213.4	10	10.2
OnPnAn	4.8	85.8	0.90	1.35	2.69	1.5	4.30	19.92	340.1	12	13.7

Description of terms used in Table 1
On Pn An = mixture of orange, pineapple and apple juice.
On = pure orange juice; Pn = pure pineapple juice; An = pure apple juice, M = moisture content.
Tu = turbidity, Tds = total dissolved solids., Con = conductivity, Sal = salinity; Br = brix value.
Ta = titratable acidity, Ts = total solids; Vc = vitamin c (ascorbic acid); Bl = bio-load.

Table 2: Physico-chemical and microbial analysis of fruit juice on post preservation after week 2.

Sample code	Parameters										
	pH	**M**	**Tu**	**Tds**	**Con**	**Sal**	**Ta**	**Ts**	**Vc**	**Bl**	**Br**
A	4.6	85.2	0.91	1.36	3.69	1.5	4.41	19.96	338.1	16	17.1
B	4.6	86.3	0.91	1.36	3.69	1.5	4.43	19.98	338.2	19	17.7
C	4.7	85.8	0.90	1.35	3.69	1.4	3.92	19.40	339.8	15	15.0
D	4.7	85.8	0.90	1.35	3.69	1.4	4.19	19.89	338.9	5.0	15.6
E	4.7	85.8	0.90	1.35	3.69	1.4	4.01	19.26	339.1	2.0	15.4
F	4.0	87.7	0.93	1.35	3.69	1.5	4.95	21.05	311.2	21	19.4
G	4.8	85.8	0.89	1.35	3.69	1.5	3.70	19.02	339.9	1.0	15.0

Description of terms used in Table 2

A = subset containing elements of the juice preserved with sodium metasulphate.

B = subset containing elements of the juice preserved with sodium benzoate.

C = subset containing elements of the juice preserved with a combination of sodium metabisulphate and sodium benzoate.

D = subset containing elements of the juice preserved by physical method of using U.V irradiation at exposure period of 1hr.

E = subset containing elements of the juice preserved by physical method using combination of U.V irradiation and ultrasonication for a period of 1hr.

F = subset containing elements of the juice without any preservatives – control experiment.

G = subset containing mixture of the juice preserved by a combination of chemical method of sodium metabisulphate and sodium benzoate as well as physical method of ultrasonication and U.V irradiation.

Table 3: Physico-chemical and microbial analysis of fruit juice on post preservation after week 4

Sample code	Parameters										
	pH	**M**	**Tu**	**Tds**	**Con**	**Sal**	**Ta**	**Ts**	**Vc**	**Bl**	**Br**
A	4.6	86.22	0.91	1.36	3.69	1.45	4.42	19.9	338.1	16	17.1
B	4.6	86.28	0.91	1.36	3.69	1.45	4.43	19.90	338.2	19	17.1
C	4.8	85.78	0.90	1.35	3.69	1.45	3.93	19.41	339.8	6.0	17.1
D	4.7	85.80	0.90	1.35	3.69	1.45	4.21	17.89	338.9	3.0	15.1
E	4.7	85.8	0.90	1.35	3.69	1.45	4.02	17.25	339.1	1.0	15.6
F	4.0	87.67	0.93	1.35	3.69	1.45	4.96	21.05	311.2	200	19.4
G	4.8	85.80	0.89	1.35	3.69	1.45	3.71	19.0	339.9	-	15.0

Table 4: Sensory evaluation before preservation

Sample code	Parameters									
	Colour			**Taste**			**Odour**		**No of**	**No of**	**No of**
	Ok	**C**	**D**	**Ok**	**Bt**	**So**	**Ok**	**S**	**Resp**	**Men**	**Women**
O		Nil	Nil		Nil	Nil		Nil	15	8	7
P		Nil	Nil		Nil	Nil		Nil	15	8	7
A		Nil	Nil		Nil	Nil		Nil	15	8	7
OnPnAn		Nil	Nil		Nil	Nil		Nil	15	8	7

Description of terms used in Table 4

Ok = okay; C = changed; D = deviated strongly; So = sour; S = stringent odour; Bt= Bitter

Table 5: Sensory evaluation during preservation after week 2

Sample code	Parameters										
	Colour			**Taste**			**Odour**		**No of**	**No of**	**No of**
	Ok	**C**	**D**	**Ok**	**Bt**	**So**	**Ok**	**S**	**Resp.**	**Men**	**Women**
A	✓	Nil	Nil		Nil	Nil		Nil	15	8	7
B	✓	Nil	Nil		Nil	Nil		Nil	15	8	7
C	✓	Nil	Nil		Nil	Nil		Nil	15	8	7
D	✓	Nil	Nil		Nil	Nil		Nil	15	8	7
E	✓	Nil	Nil		Nil	Nil		Nil	15	8	7
F	1	1	Nil		Nil	Nil		Nil	15	8	7
G	n	1	Nil		Nil	Nil		Nil	15	8	7

Table 6: Sensory evaluation during preservation after week 4

Sample code	Parameters										
	Colour			Taste			Odour		No of Resp.	No of Men	No of Women
	Ok	C	D	Ok	Bt	So	Ok	s			
A	11	4	Nil	14	1	Nil	✓	Nil	15	8	7
B	11	4	Nil	14	1	Nil	✓	Nil	15	8	7
C	13	2	Nil	13	2	Nil	✓	Nil	15	8	7
D	10	5	Nil	11	4	Nil	✓	Nil	15	8	7
E	13	2	Nil	12	3	Nil	✓	Nil	15	8	7
F	3	10	2	0	0	7	✓	Nil	15	8	7
G	4	1	Nil	14	14	0	15	Nil	15	8	7

From the physico-chemical analysis carried out on preservation of the juice samples, it was observed that subset G which was preserved by the combination of chemical methods of sodium metabisulphate and sodium benzoate as well as the physical methods of ultrasonication, U.V irradiation, including the general pasteurization given to all the other subsets, had the best preservation efficacy.

Next to subset G was subset C which was preserved by the combination of two chemical methods (sodium metabisulphate and sodium benzoate) followed by subset E which was preserved by a combination of both ultrasonication and U.V irradiation (physical methods). Next to subset E were subsets A, B and D, which were preserved with sodium metabisulphate, sodium benzoate and ultra violet irradiation respectively.

However, subset F had the worst preservation efficacy, as there was no preservative added to it. Hence it deteriorated with a short period of time. Consequently, the shelf life of subset G was the highest. Comparing the values of the physico-chemical parameters of the pre-preservation samples and the post preservation samples, it was observed that subset G maintained a uniform value of the parameters from the onset of the preservation to the end of it after week 4. Most of the other subset indicated slight variations in the parameters especially subset F that deviated strongly from the preservation.

In other words, the longest shelf life of the fruit samples was achieved by the combination of two chemical methods (sodium metabisulphate and sodium benzoate), as adopted in subset G. Therefore, the most effective shelf life was obtained from fruit the juice in subset G which was preserved with a combination of both the physical and chemical method including the pasteurization.

Conclusion

From the results obtained in the experimental work, it can be deduced that it is better to preserve fruit juice samples or their mixtures with the combination of both physical and chemical methods as well as the pasteurization, because this scheme gave a better preservation efficacy than the other preservation methods.

The production of mixtures of fruit juice, such as the case of a mixture of orange, pineapple and apple juices should be encouraged as they contain enhanced Vitamin C (ascorbic acid) and some other physicochemical parameters, which are vital to health living.

Preserving of fruit juices immediately after extraction has been shown to reduce spoilage and the effect of micro-organisms to the barest minimum.

In summary, best shelf is obtained from the most effective technique of fruit juice preservation, which is the combination of both physical and chemical method.

Fruit juices should be preserved using the method that will give longest shelf life to the juice especially if it's prepared for a prolonged consumption.

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