Standard Scientific Research and Essays Vol 10(10): 270-274, October, 2022 (ISSN: 2310-7502)
http://www.standresjournal.org/journals/SSRE

Research Article

Assessment of the Bacterial Reduction Efficacy of some Techniques on Selected Fruit Juices

[*1]Onyewenjo SC and [2]Ononuju VI

[1]Department of Biology/Microbiology, Federal Polytechnic Nekede, Owerri
[2]Department of Hospitality Management Technology, Federal Polytechnic Nekede, Owerri

***Correspondent Author Email:** sonyewenjo@fpno.edu.ng

Accepted 21 October, 2022

Abstract

Fruit juices consumptions have aided in the prevention of heart diseases, cancer, and diabetes because of their antioxidants, vitamins and minerals content. The huge economic loss associated with their spoilage demands development of effective preservation protocols. In this study, the bacterial load reduction efficacy of electric current induction (500volts and 250 volts), continuous pasteurization and microfiltration techniques were assessed on orange, pineapple and watermelon juices; and juice were subjected to microbiological examination before and after the treatments. The result obtained were as follows: bacterial load of the juices before the treatments ranged from 1.8 x 10^5 to 2.4 x 10^7 cfu/ml; after the treatments, the load ranged from nil to 3.0 x 10^4 cfu/ml. Microfiltration technique was most efficient while the 250 volts induction was the least. Bacterial isolates encountered before the treatments were *Acetobacter* sp, *Bacillus* sp, *Citrobacter* sp, *Enterobacter* sp, *Gluconobacter* sp, *Klebsiella* sp, *Lactobacillus* sp, *Leuconostoc* sp, *Proteus* sp, *Pseudomonas* sp, *Staphylococcus* sp, and *Streptococcus* sp. However, the bacterial genera that were identified after the treatments were *Bacillus* sp, *Gluconobacter* sp, and *Staphylococcus* sp. The bacterial load reduction abilities of these techniques indicate they can be used to extend the shelf life of the juices for days and weeks.

Keywords: Pasteurization, Microfiltration, Antioxidant, Electric current induction, Cancer

INTRODUCTION

Technically, fruit refers to fleshy or dry ripened ovary of a flowering plant, enclosing the seed or seeds. Thus, apples, apricots, bananas, grapes, oranges, and strawberries, as well as bean pods, corn grains, tomatoes, cucumbers, and (in their shells) acorns, almonds and wheat grains, are all fruits. Popularly, however, the term is restricted to the ripened ovaries that are sweet or sour and either succulent or pulpy edible in the raw state (Lewis, 2002; Schledel, 2003). Regular consumption of fruit is generally associated with reduced risks of several diseases and functional declines associated with aging (Wang et al., 2014). Fleshy fruits are highly perishable and mostly seasonal. To have the utilities of these fruit all year round, steps must be taken to preserve them in forms that will retain their aroma, taste, and nutrition content.

The liquid extracted from pressing fruit and vegetables is referred as Juice. It is common to consume juice as a beverage or used as an ingredient or flavoring in foods or other beverages, as for smoothies.

Juices are generally consumed for their perceived health benefits. Orange juice for example, is a natural source of vitamin C, folic acid, and potassium (Franke et al., 2005).

Juice provides nutrients such as carotenoids, polyphenols and vitamin C that offer health benefits (Benton and Young, 2019).

There are warnings of some negative effects of consumption of fruit juice, which include: not given juice to children under age one due to the lack of nutritional benefit (Heyman and Abrams, 2017).

For children ages one to six, intake of fruit juice should be limited to less than 4–6 oz (110–170 g) per day (about a half to three-quarters of a cup) (Heyman and Abrams, 2017).

due to its high sugar and low fiber content compared to fruit. Overconsumption of fruit juices may reduce nutrient intake compared to eating whole fruits, and may produce diarrhea, gas, abdominal pain, bloating, or tooth decay (American Academy of Pediatrics Committee on Nutrition, 2001).

Overconsumption of fruits and fruit juice may contribute to dental decay and cavities via the effect of fruit acids on tooth enamel. Longitudinal prospective cohort studies showed a significantly increased risk of type 2 diabetes when juices with added sugars were consumed compared to eating whole fruits (Muraki et al., 2013). A 2014 review found that higher intake of sugar-sweetened fruit juice was significantly associated with risk of type 2 diabetes (Xi et al., 2014).

Notwithstanding the warnings, fresh juice provides a convenient way of consuming fruit with most of their benefits intact. However, it has lower shelf life than the whole fruit. Preservation of the juice is necessary to ensure the extraction of the nutritionally and economic benefits of fruit production.

This research is aimed at evaluating the efficacy of some shelf life extension treatments on common fruit juices.

MATERIALS AND METHODS

Sample collections

Samples of health fruit of watermelon, pineapple and orange fruits were purchased from Relief Market Owerri, Imo state without consideration to any possible difference in production location production and genetic variation of the fruits.

Juice Extraction

The juice of the various types of fruits were extracted using electrical juice extractor after surface sterilization with 1.05% sodium hypochlorite for 60 s according to Hong and Gross (1998). The juices were received into containers that were pre-sterilized for further analysis.

Electric current induction

The various fruit juices were subjected to 500 volt and 250 volt electricity induction using ‘on’ and ‘off’ set at 5 second for 10 minutes. The juices were inducted with the stated voltage using stainless stain election connected to the electric source terminals. The methods of Jin et al. (2020) were adopted.

Continuous pasteurization

The juice types were subjected to continuous pasteurization. The system was set at the temperature of 100^{o}C with flow rate 20ml of at 5 second. The outputting juice temperature was 50^{o}c. The methods of Reeja (2020) were adopted.

Microfiltration

The fruit juices were subjected to microfiltration using filter with pore size 0.75 micrometer. The filtrates were received into sterile containers for further studies. The method of Carvalho and Silva (2010) was adopted.

Microbiological Quality Assessment

The juices (fresh and treated) were subjected to microbiological quality assessment using standard protocols and isolates were identified using biochemical test according to the methods of Cheesbrough (2000).

RESULTS

The effects of the treatments on reducing bacterial load of the juices are contained in Table 1. The 500 volts induction, continuous pasteurization and microfiltration treatments impacted a load reduction of over 99% in all the juices while the 250 volts induction impacted load reduction from 83%.

Table 1: Bacterial Load Reduction Effects of the Treatments

Treatment	Fruit Juice	Load Before treatment (cfu/ml)	Load After treatment (cfu/ml)
Electric Current Induction (500 volt)	Orange	1.8×10^5	1.9×10^1
	Pineapple	2.4×10^7	1.5×10^2
	Water melon	5.4×10^6	2.1×10^1
Electric Current Induction (250 volt)	Orange	1.8×10^5	3.0×10^4
	Pineapple	2.4×10^7	3.3×10^3
	Water melon	5.4×10^6	4.7×10^3
Continuous Pasteurization	Orange	1.8×10^5	1.5×10^1
	Pineapple	2.4×10^7	1.3×10^2
	Water melon	5.4×10^6	1.1×10^1
Microfiltration	Orange	1.8×10^5	4
	Pineapple	2.4×10^7	4
	Water melon	5.4×10^6	Nil

Table 2 contains the result of isolates from fresh watermelon juice and isolates after various treatments. From the table, *Bacillus* sp, *Citrobacter* sp, *Enterobacter* sp, *Klebsiella* sp, *Proteus* sp, and *Pseudomonas* sp were present in the juice before the treatments. After the treatments, *Bacillus* sp was re-isolated in all treatments except microfiltration and *Proteus* sp in 250 volts induction and continuous pasteurization treatments

Table 2: Effects of the treatments on Watermelon juice Bacterial Isolates

Isolates (species)	Treatments							
	500 volts ECI		250 volts ECI		Continuous Pasteurization		Microfiltration	
	BT	AT	BT	AT	BT	AT	BT	AT
Acetobacter	-	-	-	-	-	-	-	-
Bacillus	+	+	+	+	+	+	+	-
Citrobacter	+	-	+	-	+	-	+	-
Enterobacter	+	-	+	-	+	-	+	-
Gluconobacter	-	-	-	-	-	-	-	-
Klebsiella	+	-	+	-	+	-	+	-
Lactobacillus	-	-	-	-	-	-	-	-
Leuconostoc	-	-	-	-	-	-	-	-
Proteus	+	-	+	+	+	+	+	-
Pseudomonas	+	-	+	-	+	-	+	-
Staphylococcus	-	-	-	-	-	-	-	-
Streptococcus	-	-	-	-	-	-	-	-

Key: ECI= Electric Current Induction, BT= Before treatment, AT = After treatment, + = present, - = absent.

Pineapple juice isolates, before and after the treatments, is recorded in Table 3. The result reveals that the isolates from the fresh juice were *Bacillus* sp, *Enterobacter* sp, *Klebsiella* sp, *Pseudomonas* sp, *Staphylococcus* sp, and *Streptococcus* sp. After the treatments, *Bacillus* sp was re-isolated in all treatments and *Staphylococcus* sp in 250 volts induction, continuous pasteurization and microfiltration treatments

Table 3: Effects of the treatments on Pineapple juice Bacterial Isolates

Isolates (species)	Treatments							
	500 volts ECI		250 volts ECI		Continuous Pasteurization		Microfiltration	
	BT	AT	BT	AT	BT	AT	BT	AT
Acetobacter	-	-	-	-	-	-	-	-
Bacillus	+	+	+	+	+	+	+	+
Citrobacter	-	-	-	-	-	-	-	-
Enterobacter	+	-	+	-	+	-	+	-
Gluconobacter	-	-	-	-	-	-	-	-
Klebsiella	+	-	+	-	+	-	+	-
Lactobacillus	-	-	-	-	-	-	-	-
Leuconostoc	-	-	-	-	-	-	-	-
Proteus	-	-	-	-	-	-	-	-
Pseudomonas	+	-	+	-	+	-	+	-
Staphylococcus	+	-	+	+	+	+	+	+
Streptococcus	+	-	+	-	+	-	+	-

Key: ECI= Electric Current Induction, BT= Before treatment, AT = After treatment, + = present, - = absent.

Table 4 contains the result of the effects the treatments on the orange juice isolates. *Acetobacter* sp, *Bacillus* sp, *Gluconobacter* sp, *Klebsiella* sp, *Lactobacillus* sp, *Leuconostoc* sp, and *Staphylococcus* sp were isolated from fresh orange juice. After the treatments, *Bacillus* sp was re-isolated from all the treatments and *Staphylococcus* sp re-isolated from 250 volts and continuous pasteurization treatments.

Table 4: Effects of the treatments on Orange juice Bacterial Isolates

Isolates (species)	**Treatments**							
	500 volts ECI		250 volts ECI		Continuous Pasteurization		Microfiltration	
	BT	AT	BT	AT	BT	AT	BT	AT
Acetobacter	+	-	+	-	+	-	+	-
Bacillus	+	+	+	+	+	+	+	+
Citrobacter	-	-	-	-	-	-	-	-
Enterobacter	-	-	-	-	-	-	-	-
Gluconobacter	+	-	+	+	+	-	+	-
Klebsiella	+	-	+	-	+	-	+	-
Lactobacillus	+	-	+	-	+	-	+	-
Leuconostoc	+	-	+	-	+	-	+	-
Proteus	-	-	-	-	-	-	-	-
Pseudomonas	-	-	-	-	-	-	-	-
Staphylococcus	+	-	+	+	+	+	+	-
Streptococcus	-	-	-	-	-	-	-	-

Key: ECI= Electric Current Induction, BT= Before treatment, AT = After treatment, + = present, - = absent.

DISCUSSION

Fruit juice offers an attractive option of preservation of the very perishable fruit. The challenge in fruit juice preservation has been to ensure the maintenance of the sensory quality and nutritional status of the preserved juice. Qamar et al. (2017) affirmed that thermal treatment for food preservation leads to undesirable changes in quality attributes and nutritional value of food. Non thermal juice preservation option has minimal impact in the sensory qualities and nutritional status (Qamar et al., 2017). Pasteurization is a relatively mild heat treatment that causes minor changes to the nutritional and sensory characteristics of most foods. However, the shelf-life of pasteurized foods is usually only extended by a few days or weeks compared with many months with the more severe sterilization heat treatment (Fellows, 2017).

The ability to preserve fruit juice has ensured the enlargement of the fruit production economy. It has both greatly arrested the huge spoilage and economic lost associated with it. This fact discouraged investment in that direction. With advent of fruit juice preservation techniques, this is new wider frontier of business for fruit producers both locally and internationally.

The 500 volts induction, continuous pasteurization and microfiltration treatments impacted a load reduction of over 99% in all the juices while the 250 volts induction impacted load reduction from 83%. The impact of three preservative techniques evaluated on three types of juice revealed that there was reduction in microbial load of the juice after treatment. These would ensure extension of shelf life of the juice. This is in agreement with documentation of Fellows (2009) that pasteurization extends the shelf-life of acidic foods such as fruit juices for several days or weeks by destruction of spoilage microorganisms and/or enzyme inactivation. Qamar et al. (2017) stated that electric current induction into juice helps in microbial inactivation. This is consistent with result obtained.

The fresh juices and treated juices microbiological quality assessment revealed that isolates from fresh watermelon juice were *Bacillus* sp, *Citrobacter* sp, *Enterobacter* sp, *Klebsiella* sp, *Proteus* sp, and *Pseudomonas* sp. After the treatments, *Bacillus* sp was re-isolated in all treatments except microfiltration and *Proteus* sp in 250 volts induction and continuous pasteurization treatments. Pineapple juice isolates, before the treatments were *Bacillus* sp, *Enterobacter* sp, *Klebsiella* sp, *Pseudomonas* sp, *Staphylococcus* sp, and *Streptococcus* sp. After the treatments, *Bacillus* sp was re-isolated in all treatments and *Staphylococcus* sp in 250 volts induction, continuous pasteurization and microfiltration treatments. The isolates from fresh orange juice were *Acetobacter* sp, *Bacillus* sp, *Gluconobacter* sp, *Klebsiella* sp, *Lactobacillus* sp, *Leuconostoc* sp, and *Staphylococcus* sp. After the treatments, *Bacillus* sp was re-isolated from all the treatments and *Staphylococcus* sp re-isolated from 250 volts and continuous pasteurization treatments.

The use of microfiltration method led to low yield of filtrate due to fouling. Although the reduction of the microbial load was the best in all categories of juice treated, the trouble of its use will limit its industrial application if the juice is not pretreated with pectinase before filtration. This was corroborated by Carvalho and Silva (2010) who reported that the limiting factors that affect tangential filtration are concentration polarization and the fouling that occur during the process and affirmed that get around the problem, the enzymatic hydrolysis is needed as a pretreatment for membrane processes. This process has the advantages of operating at room temperature and promoting cold commercial sterilization thereby ensuring the preservation of the juice and its sensory qualities.

CONCLUSION

Continuous pasteurization, microfiltration and electric current induction at 500 volts have promising impact on the bacterial load reduction of fruit juice. This implies they can be used as ways of extension of the shelf life of fruit juice.

Acknowledgement

We are grateful to TeTfund Nigeria for sponsoring this research. This worthy gesture to boost education and research in Nigeria should be sustained

References

American Academy of Pediatrics Committee on Nutrition (May 2001). "The use and misuse of fruit juice in pediatrics". Pediatrics. 107 (5): 1210–1213.

Benton D, Young HA(2019). Role of fruit juice in achieving the 5-a-day recommendation for fruit and vegetable intake. *Nutrition Rev.* 77 (11): 829–843.

Carvalho LMJ, Silva CAB(2010). Clarification of pineapple juice by microfiltration. Ciênc. Tecnol. Aliment., Campinas. 30(3): 828-832.

Cheesbrough M(2000). District Laboratory Practice in Tropical Countries, Part 2, Cambridge University Press, UK. Pp.157-234.

Fellows PJ(2009). Food Processing Technology, Principles and Practice 3rd ed. Woodhead Publishing Retrieved from https://www.sciencedirect.com/book/9780081019078/food-processing-technology

Fellows PJ(2017). Food Processing Technology, Principles and Practice 4th ed. Woodhead Publishing. Retrieved from https://www.sciencedirect.com/book/9780081019078/food-processing-technology

Franke AA, Cooney RV, Henning SM, Custer LJ(2005). Bioavailability and antioxidant effects of orange juice components in humans. J. Agric. Food Chem. 53 (13): 5170–5178.

Heyman MB, Abrams SA(2017). Fruit Juice in Infants, Children, and Adolescents: Current Recommendations. Pediatrics. 139 (6): e20170967.

Hong JH, Gross KC(1998).Surface sterilization of whole tomato fruit with sodium hypochlorite influences subsequent postharvest behavior of fresh-cut slices. Postharvest Biology and Technol. 13(1): 51-58.

Jin Y, Yang N, Xu D, He C, Xu Y, Xu X, Jin Z(2020). Innovative induction heating of grapefruit juice via induced electric field and its application in Escherichia coli O157:H7 inactivation. RSC Advances. 10(46):27280-27287.

Lewis RA(2002). *CRC Dictionary of Agricultural Sciences*. CRC Press. ISBN 978-0-8493-2327-0.

Muraki I, Imamura F, Manson JE, Hu FB, Willett WC, van Dam RM, Sun Q(2013). Fruit consumption and risk of type 2 diabetes: results from three prospective longitudinal cohort studies. BMJ. 347 (aug28 1): f5001.

Qamar AS, Anum I, Ubaid UR, Sedia A, Rizwan S(2017). Pulsed Electric Field Technology in Food Preservation: A review. J. Nutritional Health and Food Engr. 6(6):1-4.

Reeja T(2020). Types of Pasteurization - Continuous Method. Medindia. Retrieved on Nov 03, 2022 from https://www.medindia.net/patients/patientinfo/pasteurizationofmilk_continuous.htm.

Schlegel RHJ(2003). *Encyclopedic Dictionary of Plant Breeding and Related Subjects*. Haworth Press. Pp. 177. ISBN 978-1-56022-950-6.

Wang X, Ouyang Y, Liu J, Zhu M, Zhao G, Bao W, Hu FB(2014). Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. BMJ. 349 (Jul 29): g4490. doi:10.1136/bmj.g4490. PMC 4115152. PMID 25073782.

Xi B, Li S, Liu Z, Tian H, Yin X, Huai P, Tang W, Zhou D, Steffen LM(2014). Intake of Fruit Juice and Incidence of Type 2 Diabetes: *A Systematic Review and Meta-Analysis.* PLOS ONE. 9 (3): e93471. Bibcode:2014PLoSO…993471X.