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Effect of Preservation on the Quality of Sachet Water consumed by Households in Nsukka Zone

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Abstract
The paper investigated the effect of preservation on the quality of sachet water consumed by the households in Nsukka Zone of Enugu state, Nigeria. The reason being that portable water is needed by the body and may lead to poor health problems, if poorly preserved. Four brands of sachet water were randomly selected from the seventeen brands identified in the zone. The water samples were stored at two storage environments (indoor and outdoor) and time durations were as follows: day one (as control); 2 weeks; 5weeks and 8 weeks. The samples were coded as MCW, DOW, and ETW. The samples were examined in both sensory and microbial count before they were stored in their storage environments and assessed at the treatment time durations respectively using standard analytical methods. At each treatment, time duration,48 samples of water were analyzed. The findings showed that, there were no significant difference ($P<0.05$) in the mean values at indoor storage environment for odour, and for taste, but there was a significant difference ($P<0.05$) in two brands at outdoor storage environment in odour, and in taste. A significant difference existed at the four brands stored. There was also a significant difference ($P<0.05$) in the mean values of coliform. Mould count also had significant difference ($P<0.05$) in their mean values. From the findings, it was established that all brands of sachet water produced in the zone had E. coli at day one, which is an indication of faecal contamination and indoor had the best taste and odour at two weeks and also better in microbial content.
Key words: Preservation, Quality, Sachet, Potable

1. Introduction

Water is a simple substance containing two atoms of hydrogen and one atom of oxygen (H_2O), which falls as rain and can be found in lakes and seas. Water is used for drinking and washing among others. Odilinye, Otegbulu and Ume, (2005) stated that drinking water is safe to drink, pleasant to taste and suitable for domestic purposes. Though, it has no calorific value and still everybody cell, tissues, organs and almost every life sustaining body process needs water to function. Water is a vital constituent of the body, forming about 72% of fat free weight, a medium in which virtually all body processes take place. It is a neutral substance that permits ionization of most materials (Okeke, 2009). Water is essential to sustain life and a satisfactory (adequate, safe, and accessible) supply must be available to all. Improving access to safe or potable drinking water can therefore result in tangible benefit to health (WHO, 2004).

Most potable water in Nigeria comes from three sources, which include rain water, surface water and ground water. Similarly, Okeri, Mmeremikwu and Ifeadi (2009) noted that most of the water consumed in Nigeria is obtained from rain water, lakes, rivers, springs, streams and ground water including boreholes and private wells which do not always produce pure water due to the presence of different contaminants. The authors further stated that the water obtained from these sources is subjected to various treatments by different manufacturing companies before packaging and sale or use in other manufacturing processes. Likewise Nsukka zone, which is in the northern pole of Enugu state in the eastern part of Nigeria is surrounded by streams and rivers. This zone comprises of six local government areas namely: Nsukka, Uzo-uwani, Isi-uzo, Igbo-eze north, Igbo-eze south and Udenu local government area of the state. Nwachukwu and Emeruem (2007) also noted that potable water when infected with organisms, loose its qualities and instead becomes harmful to both human and animal population.

Water quality according to Ovie and Bomoi (2005) refers to its temperature and the amount and character of its content of mineral particles, solutes and organic matter in relation to its intended use. World Health Organization (2000) advanced some standards for quality of drinking water and its safety. This standard for potable drinking water borders on such microbial factors as: total coliform of 100ml should be zero; E.coli of CPU/100ml is zero; Streptococcus Faecalis of 50ml is zero; Total plate count of CPU/100ml is zero (WHO, 2006). Standard Organization of Nigeria (2003) has its standard on packaged and unpackaged potable water as:
"coliform should be nil; E.coli is also nil; Faecalis Streptococci nil; Spore of sulphide reducing -clostridia nil".

Packaged water also known as sachet water is any water that is in sealed plastic and is distributed or offered for sale which is intended for human consumption (Nwachukwu and Emeruem, 2007). Similarly, Israel (2009) defined sachet as a disposable bag often used to contain single use of consumer goods. Bennie (2007) stated that

the plastic in which the water is packaged for the market contained micro pores which rendered it susceptible to the invasion of micro organisms when exposed to sun. Sachet water whose production lacks proper purification and thermal sterilization increases their susceptibility to contamination by both bacterial flora, exogenous contaminating microbes, as well as a variety of other contaminants including mineral salt, organic pollutants, heavy metals and radioactive residues (Dibua, Esimone and Ndianefo, 2007).The state of water may increase the contamination of these products, when not properly kept and handled during the period of preservation. Similarly, Dibua, Esimone and Ndianefo (2007), stated that water, if kept enclosed for a prolong period allows anaerobic algae and other microbes to grow in it making the water unsafe and unfit for potable use.

Method of preservation of a potable water impacts not only on its quality, but also its safety. Similarly, Okpako, Osuagwu, Duke and Ntui (2008) stated that the quality of 'Pure water' is still questionable, because many who are engaged in its production do not follow strictly the standard set by National Agency for Food, Drug Administration and Control (NAFDAC), WHO and Standard Organization of Nigeria (SON) for safe drinking water. Bennie (2007), also explained that, sachet water as a product has specific temperature conditions under which it must be kept and failure to do so, can cause serious health problems. Poor preservation of water generally may lead to health problem, since water is one of the vehicles for transmission of pathogenic organisms (Ejima, 2005).

Studies on sachet water consumed by University of Nigeria Nsukka and its environment have shown that, these water do not meet neither the NAFDAC (2004) nor World Health Organization (2006) standard (Dibua, Esimone and Ndianefo, (2007)). Sachet water whose production lacks proper purification and thermal sterilization increases their susceptibility to contamination by both bacterial flora, exogenous contaminating microbes, as well as a variety of other contaminants including mineral salts, organic pollutants, heavy metals and radioactive residues (Dibua, Esimone and Ndianefo. The state of water may increase the contamination of these products, when not properly kept during the period of preservation. Therefore the objective of this study was to determine the effect of preservation on the quality of various sachet water consumed by households in Nsukka zone.

1.1 The Purpose of the Study

The main purpose of the study was to find out the effect of preservation on the quality of various sachet water consumed by households in Nsukka zone. Specifically, the study sought to:

1. Determine the effect of preservation on odour of the four brands of sachet water, consumed by households in Nsukka zone at four specified time duration, and at two different storage environments.
2. Determine the effect of preservation on taste of the four brands of sachet water, consumed by households in Nsukka zone at four specified time duration, and at two different storage environments.
3. Investigate the effect of preservation on the microbial content of the four brands of sachet water, consumed by households in Nsukka zone using the Most Probable Number (MPN) count method (National Water Resources Institute, 1997) at four specified time duration and at two different storage environments.

1.2 Research Questions

The study sought answers to the following research questions thus;

1. What is the effect of preservation on the odour of the four brands of sachet water, consumed by households in Nsukka zone at four specified time durations, and at two different storage environments?
2. What is the effect of preservation on taste of the four brands of sachet water, consumed by households in Nsukka zone at four specified time duration, and at two different storage environments?
3. What is the effect of preservation on the micro-organisms content of the four brands of sachet water, consumed by households in Nsukka zone at four specified time duration, and at two different storage environments?

1.3 Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

HO_1: There is no significant difference on odour of the four brands of sachet water at four specified time duration, and at two different storage environments.

HO_2: There is no significant difference in taste of the four brands of sachet water at four specified time duration, and at two different storage environments.

HO_4: There is no significant difference in microorganism content of the four brands of sachet water at four specified time duration, and at two different storage environments.

2. Materials and Method

Four brands of sachet water were randomly selected by balloting from the seventeen brands of sachet

water identified to be consumed by the people of Nsukka zone. The water samples were bought from the various factories in their bags, and stored using two storage environments (indoor and outdoor) for the following durations of time: day one (fresh samples from factory labeled A which serves as control). Sample B (stored for 2weeks); Sample C (stored for 5weeks) and Sample D (stored for 8weeks). The four sample brands were coded as MCW; JIW; DOW; and ETW. A total of 168 sachets of water were used for the experiment. Six (6) sachets of water were taken from each of the four brands and were examined for both sensory quality and microbial count as control totaling 24 water samples, before the total of 144 sachets of water were stored in outdoor and indoor storage environments (i.e 72bags of water samples for each storage environment) and assessed at the various treatments time durations respectively using standard analytical methods.

The parameters examined included odour and taste as well as microbial quality. A 9- point hedonic scale was used. A ten man panel was used in assessing the taste and odour of the sachet water. The water samples were initially tested to serve as control (A) and then divided into two storage environments namely: (i) indoor (that is kept in the room); (ii) outdoor storage (kept at the corridor). Subsequently, the water samples from the various storage environments were tested at 2weeks (B); 5weeks (C) and 8weeks (D). There are fourty-eight (48) samples (6 each from the four brands) from the two storage environments. The microbiological examination of water was conducted using the Most Probable Number (MPN) Count of *Coliform* and Mould organisms in the samples. The MPN procedure is a multiple- tube dilution method using nutrient rich media and the media used were MacConkey Agar and Sabourand 4% Glucose Agar. Coliform determination was done using 40ml prepared Sabourand Agar and 0.1ml of water was poured into a petri dish and then incubated at 37^{o}C for 24 hrs and then, the colonies were counted on completion of the incubation period. The mould determination was also done using 40ml prepared MacConkey agar media and 0.1ml of water was poured into a Petri dish and then incubated at 35^{o}C for 48hrs.

Statistical Analysis

The mean values were compared using the Least Significance Difference (LSD) and the mean expressed as mean ± SD.

3. Results

Table 1: Sensory Evaluation Scores on the Effect of Preservation on odour of Sachet water

		Brands			
Storage methods	Time	MCW	JIW	DOW	ETW
	A	6.9±2.13	7.5±2.42	7.2±1.93	7.9±1.95
	B	7.4±1.96	7.4±2.22	7.9± 1.10	7.0±1.82
Indoor	C	7.5±2.32	7.3±2.11	7.5±1.90	7.3±2.00
	D	7.8±1.48	7.1±2.02	6.9±2.28	7.1±2.42
Outdoor	A	6.9±2.13	7.5±2.42	7.2±1.93	7.9±1.66
	B	6.3±2.16	7.8±1.81	6.4±3.03	6.2±2.78
	C	6.0±2.31	6.8±2.30	6.1±2.56	6.7±1.83
	D	5.9±1.73	5.5±1.96	5.4±2.37	5.8±1.75

*. The mean difference is significant at the 0.05 level.

With the indoor storage in table 1, there were no significant differences ($p<0.05$) between the odour of MCW, JIW, DOW and ETW stored at the four specified time durations. No significant difference ($p<0.05$) was shown between the odour of DOW when stored at the four specified durations outdoor.

Table 2: Sensory Evaluation Scores on the Effect of Preservation on Taste of Sachet water

		Brand			
Storage environment	Time duration	MCW	JIW	DOW	ETW
	A	7.4±1.65	7.8±1.55	7.9±0.99	7.9±0.80
	B	7.5±1.43	7.8±1.69	7.7± 1.15	7.7±0.95
Indoor	C	7.6±0.97	7.4±2.01*	7.6±0.84	7.7±1.49
	D	8.0±0.82	7.7±1.87*	7.2±1.87	7.4±1.35
Outdoor	A	7.4±1.65	7.8±1.55	7.9±0.99	7.9±0.88
	B	6.7±1.64	7.7±0.95	7.1±0.99	7.3±1.56
	C	6.4±1.27	6.6±1.17*	6.3±2.06*	6.7±1.34*
	D	6.3±1.34	5.2±1.75*	5.9±1.73*	5.8±1.69*

*. The mean difference is significant at the 0.05 level.

In table 2, there were no significant difference ($p<0.05$) between the tastes of MCW, DOW and ETW at the four specified time duration, while there were significant difference in JIW at C (5wks) and D (8wks) when stored indoor. In outdoor storage, no significant difference ($p<0.05$) was observed between the taste of MCW samples at the four specified time duration, while there were significant differences in the taste of JIW, ETW and DOW stored for C (5wks) and D (8wks).

Table 3: Effect of Preservation on micro-organism (COLIFORM) Count

		Brand			
Storage Environment	Time duration	MCW	JIW	DOW	ETW
Indoor	A	6.0±0.00	6.0±2.83	5.0±0.00	12.0±0.00
	B	8.0±0.00	28.0±0.00*	6.0± 2.83*	14.0±0.00
	C	22.0±0.00*	34.0±2.83*	24.0±5.66*	20.0±0.00*
	D	27.0±1.41*	46.0±2.83*	28.0±0.00*	27.0±1.41*
Outdoor	A	6.0±0.00	6.0±2.83	5.0±0.00	4.0±2.83
	B	8.0±0.00	14.0±0.83	12.0± 0.00*	14.0±0.00
	C	12.0±0.00*	19.0±1.41*	20.0±0.00	16.0±2.83*
	D	34.0±2.83*	32.0±0.00*	22.0±0.00	28.0±2.83*

*The mean difference is Significance at 0.05 level

In table 3, there were significant differences ($p<0.05$) between the coliforms of JIW and ETW stored at, B (2wks), C (5wks) and D (8wks). There were no significant differences ($p<0.05$) in C (5wks) and D (8wks) of DOW and MCW at indoor. There were significant difference ($p<0.05$) in the mean coliform values of MCW, JIW and ETW at C (5wks) and D (8wks) of storage, while significant differences ($p<0.05$) was noticed in DOW at all the storage time except for C (5wks) and D (8wks) in outdoor.

Table 4: Effect of Preservation on micro-organisms (MOULD) of Sachet water

		Brand			
Storage Environment	Time duration	MCW	JIW	DOW	ETW
	A	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00
	B	32.0±2.83*	00.0±0.00	0.0± 0.00	0.0±0.00
Indoor	C	37.0±1.41*	0.0±0.00	2.0±1.41*	0.0±0.00
	D	60.0±0.00*	12.0±5.66*	4.0±1.41*	6.0±1.41*
Outdoor	A	0.0±0.00*	0.0±0.00	0.0±0.00	0.0±0.00
	B	0.0±0.00	3.0±0.00	6.0± 1.41	0.0±0.00
	C	12.0±5.66*	12.0±0.00	16.0±2.83	0.0±0.00
	D	16.0±2.83*	14.0±2.83	20.0±0.00	6.0±2.83*

*. The mean difference is significant at the 0.05 level.

In table 4, there were significant difference ($p<0.05$) between the mould count of MCW and DOW at C (5wks) and D (8wks), while JIW and ETW also showed that, there were significant difference ($p<0.05$) in the mould count at D (8wks) when stored indoor. No significant difference in the mould count of JIW and DOW at A, B, C and D, while MCW had significant difference in the mean mould count on A (day one), C (5wks), and D (8wks) of storage and ETW had significant difference on mould count at D (8wks) of outdoor storage.

4. Discussion of Findings

The odour of water sampled indoor were noticed to have slight change as the experimental period lasted in all brands. Though MCW had the best odour followed by ETW, then JIW and lastly DOW. Looking at the table 1, it was observed that MCW and DOW mean increased in odour, but at eight weeks the odour declined, while JIW and ETW decreased progressively as the storage period increased. In outdoor samples, the odour of water sampled was observed to have deteriorated moderately, at eight weeks of storage in all the four brands of sachet water with MCW still having the best odour as compared to ETW, JIW and DOW being the least. This observation agreed with Giese (2000), who noted that the quality of a packed food, drink or medicine and other perishable items decreases over time.

The mean values on taste of water samples decreased in JIW, DOW and ETW while there was an increase in MCW as the storage time increased in indoor as compared with the control at 8wks. Although, the control samples were not 100% taste free. Outdoor samples also experienced tremendous decrease in taste in all the brands of the four sachet water, because at eight weeks the taste of water samples had declined. Thus MCW had the best taste, followed by DOW, ETW and JIW. This observation agreed with Giese (2000) who noted that small

temperature change can have large effects on product keeping quality.
All brands of water sampled had coliform from day one. This result corresponded with the study conducted by Dibua, Esimone and Ndianefo (2007) which noted that the bacteriological indices of contamination detected from the majority of sachet water samples are neither indication that the 'pure water' available in the university environment do not meet the NAFDAC (2004) nor the WHO (2003) standard and so may not be suitable for drinking purposes. The study conducted by Ekpo and Eddy (2005) at Akwa Ibom state, on the assessment of the quality of sachet and bottled water, also corresponded with the present study, on its findings on total coliform isolation. The coliform mean values increased in all the water sampled indoor as the storage period continued, though, JIW water had the highest coliform count when stored indoor. Coliform count also showed progressive increase in all brands in outdoor storage. In comparison of the two storage environments, it was noticed that JIW and DOW at indoor storage had more coliform at D (8wks) than JIW and DOW at outdoor 8wks, while MCW and ETW at outdoor had more coliform at 8wks than MCW and ETW at indoor.
Generally, moulds were found in the stored water samples and were identified as follows: *Cladosporium sphaerosperum spp, Curvularia lunata spp*, and *Cladosporium macrocarpum spp.* However, these mould species were found in the two storage environments of the sampled water brands. With the mould count, all brands of water sampled as control were free of mould contamination at day one (A). Though as the storage duration continued, MCW was infested with mould count at 2weeks 8weeks of storage. While DOW had moulds count at the 5th week and continued to the 8th week of storage. JIW and ETW had mould count only at the 8th week of storage indoor. Looking at the outdoor Colum of the table 4, JIW and DOW had mould count of at 2 weeks and continued to the 8th week. While MCW was infested with mould at the 5th week and continued to the 8th week of storage. ETW was not also left out in the mould infestation, but this only occurred at the 8th week of storage. The presence of mould in this water samples may have occurred as a result of long keeping time, which agreed with Adofo (2009), that water kept enclosed for a prolonged period allows anaerobic algae and other microbes to grow in it, thereby making it unsafe and unfit for potable use.
When mould count of indoor and outdoor sachet water were compared, it was observed that MCW stored at indoor was higher than the moulds count in outdoor storage, while JIW and DOW moulds count were slightly higher in outdoor than at indoor storage. This may be as a result of the weather condition when the experiment was conducted (July to September). This is a period of heavy rainfall and relative humidity at Nsukka zone. The observation was in line with Pollard (2010) and Elizabeth (2010) who noted that humidity, temperature, exposure to sunlight and the type of container used during storage affect the safety of products (water or food). Similarly, the result also agreed with Dada (2009) who also noted that, temperature is a major factor in determining the keeping quality of sachet water, as high temperature influences the re-growth potentials of micro organisms. Wright (2009) also stated that, it is only when a product is kept at a constant temperature that has no extremely highs or lows, that would keep its quality.

5. Recommendations

1. Ideal preservation method should be exposed to the people concern with sachet water production, distribution and consumption in the zone and the nation at large.
2. For the safety of sachet water consumers, the storage duration should not exceed fourteen (14) days of production at all levels of storage.
3. Research on Home Economics Education (especially Foods and Nutrition) should also focus attention on water processing and consumption, as water borne diseases are transmitted through the consumption and utilization of water in the home.

5.1 Conclusion

The findings established that all brands of sachet water produced in the zone had E.coli at day one, which is an indication of fecal contamination. The analysis of result showed that, Indoor environment had greater advantage over outdoor in micro-organisms content in some brands of sachet water at four specified time durations, and at 2weeks taste and odour over outdoor storage in all the brands of sachet water considered in this study. Finally, the study recommended that the storage duration of sachet water should not exceed 14 days (2wks) of production at all conditions of storage for the purpose of consumer safety.

References

Bennie, J. (2007), Food and Drug Board raises alarm over sachet water handling: Ghanaian Chronicle online. Assessed on the 24th of July 2010 from http://news2/285956/1/modernghana.com/food-and-drugs-board-raises-alarmover-handling-of-,html
Dada, A.C. (2009), Towards a Successful Packaged Water Regulation in Nigeria. *Academic Journal online* Assessed on the 22nd April, 2010 from http://www.academicjournals.org/sre
Dibua, U.E., Esimone, C.O., and Ndianefo, P.C. (2007), Microbiological and Physical Characteristics of sachet

water samples marketed in Nsukka campus of the University of Nigeria. *Bio – Research a publication of the Faculty of Biological Sciences,* 5 (1): 189-193.
Ejima, S.O. (2005), Environment and Health Hazards. Implication on students in colleges of education in Ankpa, Kogi State. *Teacher Education Journal* 13 (2) 86-91.
Ekpo, A.S. and Eddy, N.O. (2005), Assessment of the Quality of Sachet and Bottled water in Akwa Ibom state south eastern Nigeria. *Proceeding of the 28th International Conference of the Chemical Society of Nigeria. 2(2) :363-366*
Elizabeth, M. (2010), Introduction to Food Storage. Retrived on the 22nd of March, 2010 from http://www.homeinstitute.com/introduction_to_foodstorage.htm
Giese, J. (2000) Keeping quality testing Retrieved on 10th March, 2010 from http://www.google.co.za/shelf_life_testing.pdf.
Israel, O. (2009), Definition of Sachet. Retrived on 1st October, 2009 from http;//www.brainquote.com/words/an/sachet (Wu xing)
Nwachukwu, C. and Emeruem, C.M. (2007), Presence of Antibiotic Resistant Bacteria in Sachet water Produced and Sold in the Eastern Nigeria. *Assessed from Research Journal of Microbiology.* 2(10): 782 - 786.
Odilinye, N. R., Otrgbulu, V. C and Ume, J . I. (2005) Quality Survey of Well Water Samples from some locations in Enugu South Local Government Area of Enugu State in the 28th *Proceeding of Chemical Society of Nigeria* 2(2):561 – 564.
Okeke, S.U.N. (2009), Home Economics for schools and colleges. Onitsha: AFP Africana first publishers.
Okpako, E.C., Osuagwu, A N., Duke, A. E. and Ntui, V. O. (2008) Prevalence and Significance of Fungi in Sachet and Borehole Drinking Water in Calabar, Nigeria, *African Journal of Microbiology Research* 3(2) online http://www.academicjournals.org/ajm
Ovie, R. and Bomoi, A.M. (2005), Quality of Available Water in Damaturu Metropolitan (A case study of Nayinawa and Pompomari) in 28th *Proceeding of the chemical society of Nigeria* 2 (2): 555 - 560
Pollard, R. (2010) Food Storage and Shelf-life. Retrived on the 10th of April, 2010 from http://wellregulatedamericanmilitias.com/group/texashomesurvivalpreparations/forum/topics/food_storage_and_shelf_life
World Health Organization (WHO, 2000), Guidelines for Drinking Water Quality –Training Pack. Retrieved on 5th may 2009 from http://127.0.0.1/gsd1?e=d.0whowater--000--0-0--01-0st0--0-10lef--1
World Health Organization (WHO, 2006), Guidelines for Drinking Water Quality– incorporating first Addendum to third edition 1: Recommendation. Retrieved on 5th May, 2009 from http://www.who.int/water-sanitation health.
Wright, A. (2009), Introduction and Factors affecting Storage. Assessed on the 10th of April, 2010 from http://www.waltonfeed.com/blog/show/article_id/163

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