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Chemical properties of water sources for cassava processing in selected areas of Southwest Nigeria

O.O. Abiona[1], L.O. Sanni[2]* and S. O. Awonorin[2]

*[1]Department of Food Science and Engineering, Ladoke Akintola University of Technology,Ogbomoso, Nigeria. [2]Department of Food Science and Technology,University of Agriculture,P. M. B. 2240, Abeokuta, Nigeria. *e-mail:lateef_2@yahoo.com, lsanni@cgiar.org*

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Abstract

Chemical properties of water sources for cassava processing in selected areas of Southwest Nigeria were evaluated. Water samples were aseptically collected from Ilaro, Ibadan and Abeokuta using sterile containers and analyzed for chemical properties. There were significant differences ($P< 0.05$) between sampling sites for organic matter (0.2-8.6 mg/l), BOD_5 (0.3-3.1 mg/l), COD (3.3-6.7 mg/l), total solids (56.0-108.6 mg/l), suspended solids (21.5 - 48.3 mg/l), nitrate, nitrite, ammonia, sodium, potassium and chloride in water samples. The study showed that processing environment has significant effect on pH, dissolved oxygen concentration, organic matter, BOD_5 ,COD, OM, total solids and suspended solids within the processing locations.

Key words: Chemical properties, water sources, processing environment.

Introduction

Currently, the potentials for the acceptability and demand for products from root and tuber crops are increasing provided they are of high quality and safe. Production of safe, high quality and convenient forms of cassava products has been reported to have the potential to add value to production, increase rural incomes and results in products that will be acceptable to urban consumers[5,6]. The extent of commercial activities and location of cassava processing sites closed to streams or surface water have direct influences on safety of products. Therefore, it is important to control the quality of water used in cassava processing. This study evaluates the chemical properties of water sources for cassava processing at selected sites in Ibadan, Abeokuta and Ilaro.

Materials and Methods

The sampling areas were Ibadan, Abeokuta and Ilaro. The selection was based on the extent of commercial activities and location of processing sites closed to streams or surface water. Water samples were aseptically collected using sterile containers and following parameters were determined: pH, temperature, alkalinity, dissolved oxygen, biological oxygen demand (BOD_5), total solids (TS), total dissolved solids (TDS) and suspended solids (SS). Total solids and total dissolved solids were determined gravimetrically. The concentration of suspended solids was calculated as the difference between TS and TDS. Potassium dichromate method [1] was used to measure the COD (chemical oxygen demand). Ions in water samples were investigated using standard methods [1]. NH_4^+, NO_3^-, NO_2^-, PO_4^{3-} and SiO_3^{2-} were determined using spectrophotometer (Spectrophonic 20D) at optimal wavelengths of 419, 690 and 410 nm. Na^+ and K^+ were determined photometrically using the flame emission analyzer (Model PFP7/ CJENWAY). Cl^- was determined titrimetrically according to standard method [1]. The statistical analyses were performed with Hewlett Pack 41 CV equipped with SPSS software package. Data obtained were subjected to two-way analysis of variance and means were separated using Duncan's multiple range test.

Results and Discussion

Table 1 presents the chemical properties of water sources used for cassava processing. There was no significant difference among mean temperatures at Ibadan, Abeokuta and Ilaro. The pH values of all investigated waters fall within the acidic range of 3.0 - 6.2. Ilaro water was more acidic (pH 3.9) than that from the other sampling sites. Most of these values fall below recommendation

Table 1. Chemical properties of water sources used for cassava processing.

Parameter	Ibadan	Abeokuta	Ilaro
Temperature °C	27.0 ± 1.5[a]	25.5 ± 0.0[a]	27.7 ± 0.3[a]
pH	4.8 ± 0.7[a]	5.1± 0.1[a]	3.9± 0.1[a]
Alkalinity mg/l	7.3 ± 1.2[a]	4.7± 1.5[a]	3.0 ± 0.0[a]
Dissolved oxygen mg/l	2.6 ± 0.3[a]	2.3 ± 0.7[a]	1.9 ± 0.1[a]
Organic matter mg/l	3.3 ± 0.5[b]	8.6 ± 0.1[a]	0.2 ± 0.1[c]
BOD_5 mg/l	3.1 ± 0.9[a]	2.7 ± 0.3[a]	0.3 ± 0.0[b]
COD mg/l	6.7 ± 4.7[a]	3.3 ± 0.2[b]	6.5 ± 0.1[a]
TS mg/l	62.9 ± 1.4[b]	108.6± 1.6[a]	56.0 ± 0.4[c]
SS mg/l	21.5 ± 1.2[b]	48.3 ± 0.7[a]	45.0 ± 0.8[a]
TDS mg/l	41.3 ± 3.4[b]	60.3 ± 1.9[a]	11.0 ± 1.0[c]

Values are means±standard deviation. Each value represents mean of three replicates.
Mean values having the same superscript within rows are not significantly different at 5% confidence level.

range for domestic water supply (Table 2). The alkalinity values were generally low, since the water sources were acidic, even though there were variations, the differences were not significant. Dissolved oxygen concentration ranged from 1.9-2.6 mg/l with water samples from Ibadan recording the highest values. Nuisance algae and anaerobic organisms might become abundant in waters with low level of dissolved oxygen, hence the water source in Ilaro is more susceptible to microorganisms. In general there were significant differences ($P< 0.05$) in OM, BOD_5, COD, TS, TDS and SS. OM, BOD_5 and COD were used in estimating the level of organic pollution in investigated waters. The results showed that higher values recorded for organic pollution in Ibadan calls for stricter sanitary measure.

Table 3 presents the concentration of major ions in water collected from Ibadan, Abeokuta and Ilaro. Generally there were significant differences ($P< 0.05$) in values of the three most important nitrogen compounds (nitrate, nitrite and ammonia) in water. Even though they are useful, they can be toxic when concentrations exceed certain limits. The nitrate content of Abeokuta source was higher than that of Ibadan and Ilaro. Because of the potential toxicity, water sources in Abeokuta environment need to be carefully treated before water is used for cassava processing.

The concentration of phosphate ranged from 30.0 to 69.3 mg/l (Table 3). Phosphorus in natural waters is present as PO_4-P and comes from several sources including human and animal wastes etc. As eutrophication increases, the entire water source might be filled with aquatic vegetation and the advanced stage of eutrophication can produce anaerobic conditions in which oxygen in water is completely depleted. The implication of this is that phosphorus content of water sources should be minimal. Using the WHO standard (Table 2) as comparison, the water sources tested were of high quality.

The concentration of silicate was between 4.1±1.4 and 5.2±3.0 mg/l (Table 3). These values fall within required range for normal biological balance. Silica is a very important component of diatom skeleton and exists in water as dissolved silicate [2]. Diatoms are useful for the enrichment of water bodies. Powers and Ayers [3] reported that a decline in silica content of water is associated with a change in the composition of algal flora from diatom to less desirable blue green algae (cyanobacteria).

Generally, there were significant differences ($P<0.05$) in values of sodium, potassium and chloride analysed for water samples within the cassava processing locations. Sodium content of collected water samples ranged from 0.9 to 3.1 mg/l (Table 3). Since the level of the dissolved sodium has not been linked to health hazards and it is an essential constituent of living organisms, high concentration of it in an ecosystem is desirable. The concentrations of potassium and chloride varied generally for all locations and are lower than what WHO recommended as upper limits (Table 2). The above indicates that the water sources in the project areas are of high quality.

Table 2. Guidelines on drinking water by World Health Organisation (WHO) and National Agency for Food and Drug Administration and Control (NAFDAC), Nigeria.

Parameter	Max. acceptable concentration (WHO)	Max. allowable concentration. (NAFDAC)
pH	7.0 - 8.5	6.5 - 8.5
Total solids (mg/l)	1000	500
Alkalinity (mg/l)	100	100
Iron mg/l	0.05 - 0.3	-
Magnesium (mg/l)	50	30
Chloride(mg/l)	200	200
Copper (mg/l)	2.0	-
Nitrate (mg/l)	50	-
Nitrite (mg/l)	3	-
Potassium (mg/l)	1 - 2	10
Cadmium (mg/l)	0.003	-
Chromium (mg/l)	0.05	-
Lead (mg/l)	0.01	-
Silica (mg/l)	100	-

Source:NAFDAC, Oshodi, Lagos (1998)

Table 3. Concentration of major ions in water sources.

Parameter	Ibadan	Abeokuta	Ilaro
$NH_4^+ \times 10^{-3}$ (mg/l)	163.7 ± 2.9^a	62.7 ± 2.3^b	54.3 ± 5.5^c
$NO_2^- \times 10^{-3}$ (mg/l)	2.0 ± 2.0^a	0.7 ± 1.2^b	2.0 ± 2.0^a
NO_3^- (mg/l)	1.7 ± 11^b	4.2 ± 3.6^a	0.7 ± 0.8^c
$PO_4^{3-} \times 10^{-3}$ (mg/l)	43.3 ± 1.5^b	30.0 ± 0.00^c	69.3 ± 1.0^a
SiO_3^{2-} (mg/l)	4.4 ± 1.6^b	4.1 ± 1.9^b	5.2 ± 3.0^a
Na^+ (mg/l)	3.1 ± 0.3^a	0.9 ± 0.5^c	1.3 ± 0.5^b
K^+ (mg/l)	2.9 ± 0.7^a	2.3 ± 0.8^a	1.5 ± 0.7^b
Cl^- (mg/l)	7.8 ± 0.5^a	$5.9 \pm 0.8^{a,b}$	4.3 ± 0.5^b

Values are means±standard deviation. Each value represents mean of three replicates.
Mean values having the same superscript within rows are not significantly different at 5% confidence level.

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