African Journal of Biotechnology Vol. 4 (8), pp. 829-832, August 2005
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2005 Academic Journals

Full Length Research Paper

Some mineral profiles of fresh and bottled palm wine – a comparative study

Ukhun, M.E.[1]*, Okolie, N.P[2] and Oyerinde, A.O[1]

[1]Department of Chemistry, [2]Department of Biochemistry, Faculty of Science, University of Benin, P.M.B. 1154, Benin City. Nigeria.

Accepted 27 June, 2005

Some mineral profiles of fresh palm wine and those of seven brands of bottled palm wine were analysed using atomic absorption spectroscopy and the values were compared. Three of the bottled samples contained toxic levels of either Pb or Cd or both. Neither metal was detected in fresh palm wine. Zn, Cr and Ni were 2 to 15 times higher while Cu was 2 to 5 times lower in bottled samples than values for fresh sample. The likelihood of water- derived heavy metal contamination during bottling, and its potential health implication for consumers are discussed.

Key words: Palm wine, bottling, mineral elements.

INTRODUCTION

Palm wine is a popular traditional alcoholic beverage consumed by more than 10 million people in West Africa (FAO, 1998). It is a sweet, effervescent drink obtained from the sap of the oil palm, *Elaeis guineense* and raphia palm, *Raphia hookeri*. The drink is a rich nutrient medium containing sugars, protein, amino acids, alcohol and minerals (Ezeagu and Fafunso, 2003). It also contains a dense population of yeasts (Bassir and Maduagwu, 1978). Thus when it is allowed to stand, fermentation converts the sugars to ethanol and subsequently to acetic acid, leading to loss of sweetness, shortened shelf life and decreased acceptability (Odunfa, 1985). The major objective of bottling is to prolong the shelf life of palm wine by arresting yeast growth and taste deterioration. Essentially, the process involves filtration of fresh palm wine, dilution with water, bottling and pasteurization. Thus water is an important input in palm wine preservation although this is often denied or even masked by addition of artificial sweeteners. Indeed one of the most frequent complaints of palm wine consumers is the adulteration of the product by use of water and artificial sweeteners, which sometimes result in diarrhoea, abdominal pains and stomach problems (GRI, 2004). Recently it was reported that the ground water in Benin City is contaminated with unacceptable levels of Pb, Cd, Cr, and Zn (Erah et al., 2002). Moreover, unacceptable levels of Pb have been detected in a major source of public water supply in Benin City (Tawari – Fufeyin, 1998). Since palm wine bottling is still carried out as a small scale enterprise involving the possible use of low quality water, there is a distinct possibility of contamination of the products with undesirable minerals.

This study was therefore carried out to compare some elemental compositions of bottled and fresh palm wine in Benin City, Nigeria. Benin has one of the highest concentrations of palm wine bottling outfits in the country. Additionally, increasing urbanization in Nigeria creates the potential for an accentuated interaction between food and an increasingly contaminated environment.

MATERIALS AND METHODS

Palm wine samples

Seven brands of bottled palm wine were purchased from retail outlets in Benin City, Nigeria. Fresh, unprocessed palm wine was obtained from the Nigeria Institute for Oil Palm Research (NIFOR) near Benin. Prior to analysis, the samples were kept in clean, dry bottles previously washed and rinsed with hot de-ionized water.

*Corresponding author. E-mail: tamjele@yahoo.com. Phone: +234-08034738849.

Table 1. Profiles of some mineral elements in bottled and fresh palm wine.

Mineral	I	II	III	IV	V	VI	VII	Fresh Palm wine
Zn	4.03± 0.05	3.43 ± 0.04	2.95 ±0.05	1.26± 0.07	6.54 ±0.24	4.94 ± 0.04	8.88 ±0.45	0.98 ± 0.07
Pb	ND	ND	ND	ND	0.12 ± 0.05	ND	0.03 ± 0.01	ND
Cr	0.08 ± 0.01	0.11 ± 0.02	0.11 ± 0.01	0.04 ±0.01	0.36 ± 0.05	0.18 ± 0.03	0.31 ± 0.03	0.02 ± 0.00
Cd	ND	ND	ND	ND	ND	0.31 ± 0.03	0.05 ± 0.01	ND
Ni	0.10 ± 0.01	0.14 ± 0.03	0.14 ± 0.01	0.15 ±0.03	0.13 ± 0.02	0.28 ± 0.08	0.09 ± 0.02	0.08 ± 0.02
Cu	2.43 ± 0.03	4.03 ± 0.64	3.61 ± 0.13	1.07 ± 0.05	7.52 ± 0.83	3.99 ± 0.08	2.00 ±0.07	5.80 ± 0.09

Values are mean ± SEM of triplicate determinations.
ND = Not detected.

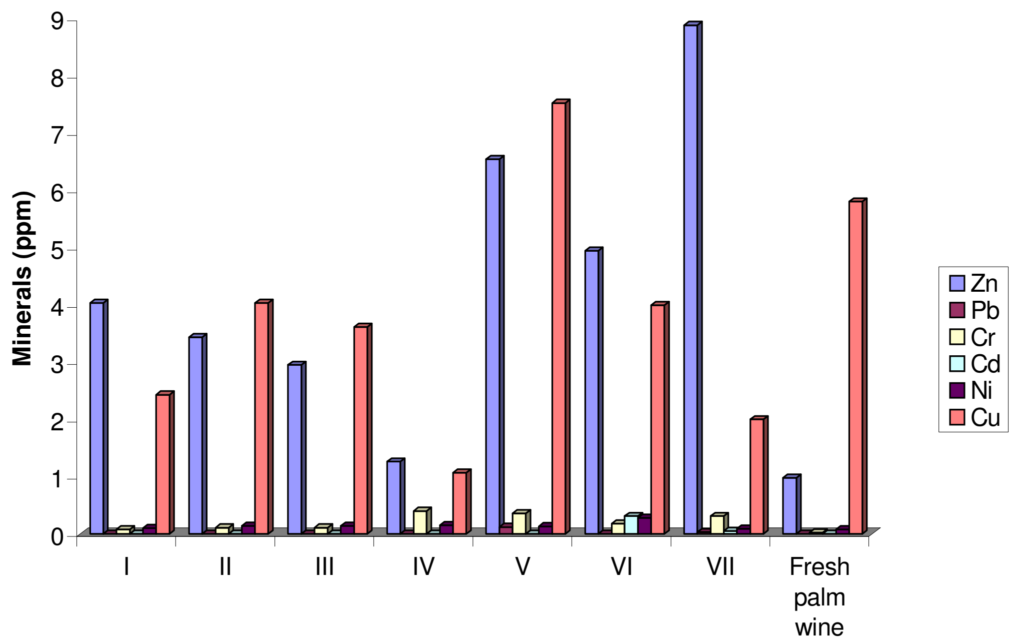

Figure 1. Profiles of some mineral elements in bottled and fresh palm wine.

Analysis of samples for minerals

The specimens were first subjected to micro-kjeldah digestion before analysis of their mineral profiles by atomic absorption spectrophotometry (Agemian et al., 1980). To 5 ml of each sample in a micro-kjeldah flask were added 5 ml of concentrated nitric acid and 5 ml of concentrated sulphuric acid. The flask was placed on a heating mantle and maintained at 60℃ for 30 min. On cooling, 10 ml of concentrated nitric acid was added, and the flask was further heated to 150℃ until its contents became charred. It was then cooled to room temperature (29℃) and 1 ml of 3% (v/v) H_20_2 was added. Heating was resumed, with addition of more H_20_2 until the solution became clear. On cooling, it was filtered and diluted to 50 ml in a volumetric flask. Cu, Pb, Ni, and Cr were first concentrated by chelating solvent extraction before analysis. For this purpose 40 ml of the digest was transferred into a 100 ml volumetric flask and made up to mark with de-ionized water. The solution was put in a separating funnel and 5 ml each of ammonium pyrolidine dithiocarbamate (APDC) and methylisobutyl ketone (MIBK) was added. The mixture was thoroughly shaken for 5 min, and on standing, the lower aqueous layer was discarded, while Cd, Pb, Ni and Cr were assayed in the MIBK layer. The amount of each element in sample was obtained from a standard calibration curve prepared using serial dilutions of 100 ppm of each metal in 10% (v/v) sulphuric acid.

RESULTS AND DISCUSSION

Zn, Cr and Ni levels were 2 to 15 times higher in bottled palm wine when compared with corresponding values for fresh palm wine, except in two cases where the Ni contents of fresh and bottled samples were comparable (Table 1, Figure 1). Pb and Cd were detected in two bottled samples each, while one of the bottled varieties had both Pb and Cd. However neither Cd nor Pb was detected in fresh palm wine. Cu distribution followed an irregular pattern, being higher in fresh palm wine than in many of the bottled samples.

The World Health Organization (WHO) recommended limits for Pb and Cd in drinking water are 0.10 and 0.003 ppm, respectively (WHO, 1998). Thus the levels of these metals in some of the bottled palm wine samples are potentially toxic. Sources of human exposure to Cd include atmospheric, terrestrial and aquatic routes (Wolnik et al., 1985; Lopez et al., 1994); as well as phosphate fertilizer (Jackson and Alloway, 1991, Mclaughlin et al., 1996). The most severe form of Cd toxicity in humans is “Itai-itai”, a disease characterized by excruciating pain in the bone (Kasuya et al., 1992; Yasuda et al., 1995). Other health implications of Cd in humans include kidney dysfunction, hepatic damage and hypertension (Klaassen, 2001). However, it has been suggested that overall nutritional status (rather than mere Cd content of food) is a more critical factor in determining Cd exposure (Vahter et al., 1996). Thus the nature of the diet, as well as the status of Fe, Zn and other minerals is vital. It has been shown that Zn and Cu competitively inhibit Cd uptake by cells (Endo et al., 1996). The recommended daily intake of Zn is between 4 and 16 mg depending on age, sex and physiological state (FNB, 1974). Zn is an essential element to man, being a cofactor for many enzyme systems. It has been reported to competitively inhibit Pb uptake in cells (Alda and Garay, 1990; Lou et al., 1991). Toxic levels of Pb in man have been associated with encephalopathy, seizures and mental retardation (Schumann, 1990). From the foregoing, it can be argued that the presence of Zn in some of the bottled palm wine at levels above the 3.0 ppm recommended by WHO may be an advantage.

Virtually all the bottled palm wine brands contained chromium in excess of the recommended limit of 0.05 ppm for drinking water (WHO, 1998). This indicates that chromium overload may result from excessive indulgence in these products. Although chromium in an essential mineral, being a component of the glucose tolerance factor that potentiates the effect of insulin (Mertz, 1993), chromium toxicity in man has been limited to hemorrhage, respiratory impairment and liver lesions (Rhode and Hartmann, 1980). Nickel toxicity in man is unknown. Indeed the element is sometimes used to line cooking utensils and pasteurization equipment. The slightly higher levels of Ni in some of the bottled samples may be a consequence of contamination during handling. The general limit of Cu in most foods is 20 ppm (Pearson, 1976). Thus, palm wine, processed or unprocessed is a poor source of this trace element.

From the results obtained in this study it is clear that except for Cu, all the minerals analysed were either not detected in unprocessed palm wine or were present at much lower levels than in the bottled analogues. This strongly suggests that most of these minerals might have resulted from contamination during the bottling process, most likely from the dilution water. This deduction is supported by a recent finding which indicates that the ground water in Benin City is contaminated with unaccepted levels of Pb, Cd, Cr and Zn (Erah et al., 2002). In addition, ground water is a major source of industrial and public water supply, not only in Benin City, but also in many parts of Nigeria. The variabilities in the levels of the various minerals may be attributable to non-uniformity in water quality among the bottling outfits, as well as likely differences in palm wine handling. In view of the toxicities of Pb and Cd, this study has underscored the need for optimum water quality in the palm wine bottling industry.

REFERENCES

Agemian H., Sturtevant, DP, Auten, KD (1980). Simultaneous acid extraction of six trace metals from fish tissues by hot block digestion and determination by atomic absorption spectrometry. Analyst 105: 125 -130.

Alda JO, Garay R (1990). Chloride (or biocarbonate)- dependent copper uptake through anion exchanger in human red blood cells. Amer. J. Physiol. 259: C570- 576

Bassir O, Maduagwu EN (1978). Occurrence of nitrate, nitrite, dimethylamine and dimethlynitrosamine in some fermented Nigeria beverages. J. Agric. Food Chem. 26: 200-203.

Endo T, Kimura O, Sakata M (1996). Effects of zinc and copper on uptake of cadmium by LLC – PKI cells. Biol. Pharm. Bull. 19: 944 - 948.

Erah. PO, Akujieze CN, Oteze GE (2002). The quality of ground water in Benin City: A baseline study on inorganic chemicals and microbial contaminants of health importance in boreholes and open wells. Trop. J. Pharm. Res. 1: 75-82

Ezeagu IE, Fafunso MA (2003). Biochemical constituents of palm wine. Ecology Food Nutr. 42: 213 – 222

FAO (1998). Fermented fruits and vegetables. A global perspective. Agricultural Services Bulletin of Food and Agricultural Organization no 134

FBN (1974). Recommended dietary allowances. Food and Nutrition Board, National Academy of Sciences, Washington DC

GRI (2004). Palm wine dying a painful death. A feature by Ghana Review International.

Jackson AP, Alloway BT (1991). The bioavailability of cadmium to lettuce and cabbage in soils previously treated with sewage sledges. Plant Soils 132:179-186.

Kasuya M, Teranishi H, Aohima K, Katoh T, Horiguchi, H, Morikawa Y, Nishijo M, Iwata K (1992). Water pollution by cadmium and the onset of “Itai-itai” disease. Water Sci. Technol. 25:149 – 156

Klaassen CD (2001).Heavy metals and heavy metal antagonists. In: Hardman JG, Limbird LE, Gilman AG (eds). Goodman & Gilman's : The Pharmacological Basis of Therapeutics, McGraw Hill, New York, pp. 1851-1875.

Lopez MC, Cabrera C, Gallego C, Lorenzo ML (1994). Cadmium levels in waters of Canada Coast. Arch. Pharm. 1: 945 – 950

Lou M. Garray R, Alda J (1991). Cadmium uptake through the anion exchanger in human red blood cells. J. Physiol. 443: 123 – 136.

Marzenko Z (1976). Spectrometric determination of elements. John Wiley and Sons Inc, New York

Mclaughlin MJ, Tiller RG, Naidu R, Stevens DP (1996). Review: the behaviour and environmental impact of contaminants in fertilizers. Aust. J. Soil Res. 34: 1-54.

Mertz W (1993). Chromium in human nutrition: a review. J. Nutr. 123: 626

Odunfa SA (1985). African Fermented Foods. In Microbiology of Fermented Food. Elsevier Applied Science Publishers, UK.

Pearson D (1976). The Chemical Analysis of Foods. Churchill Livingstone, Edinburgh.

Rhode B, Hartmann G (1980). Introducing mycology by examples. Schering Aktrengesellschaft, Hamburg.

Schumann K (1990). The toxicological estimation of the heavy metal

content (Cd, Hg, Pb) in food for infants and small children. Z. Ernahrungswiss 29:54 – 73.
Tawari-Fufeyin P (1998). Heavy metal levels in some dominant fish of Ikpoba Reservoir in Benin City. J. Environ. Rev. 2: 61-69.
Vahter M, Berghund M, Nermell B, Akesson A (1996). Bioavailability of cadmium from shell fish and mixed diet in women. Toxicol. Appl. Pharmacol 136: 332 -334.
WHO (1998). Guidelines for drinking water. World Health Organization health criteria and other supporting information. pp 940 -949.
Wolnik KA, Frick FL, Caper SG, Meyer MW, Satzergar RD (1985). Elements in major raw agricultural crops in the United States. 3. Cadmium, lead and eleven other elements in carrots, field corn, onion, rice, spinach and tomatoes. J. Agric. Food Chem. 33: 807 – 811.
Yasuda M, Miwa A, Kitagawa M (1995). Morphometric studies of renal lesions in “Itai – itai” disease: chronic cadmium nephropathy. Nephron 69: 14-19.