Food Chemistry **34** (1989) 89–94

Industrial Processing of Palm Juice and Riboflavin Loss

Olufunmike Alalade Ajayi, Emma O. Fakiya
& Gabriel O. Oladapo

Department of Human Nutrition, University of Ibadan, Ibadan, Nigeria

(Received 19 February 1988; revised version received and
accepted 8 December 1988)

ABSTRACT

The effect of processing or season, or exposure to atmospheric temperature on riboflavin content of industrially bottled palm juice was studied. Losses occurred in riboflavin content throughout the processing stages but loss was more pronounced after the filtration stage. The pasteurized palm juice contained about 60% of the initial riboflavin while the riboflavin content of fermenting palm juice increased significantly ($P < 0{\cdot}01$) with time of exposure. Losses occurred in pasteurized 'non-fermenting' samples similarly exposed. On the other hand, losses were not observed in pasteurized samples stored in the dark for 6 weeks.

Sun-inactivation may explain the significantly lower riboflavin content of samples processed in the dry compared to those processed in the rainy season. Findings from the study suggest that the nutritional value of processed palm juice may be raised if fermentation is allowed to proceed for 10 h before processing commences. Also, synthetic riboflavin may be incorporated at the pasteurization stage in non-fermenting juice.

INTRODUCTION

Processing or food preparation may affect the riboflavin content of foods. Fermentation, besides adding variety to meals, increases the nutritional value of food (Van Veen & Steinkraus, 1970; Andah & Muller, 1973). In Nigeria, fermented foods are consumed as condiments (used in preparation of soups, sauces, etc.) beverages, or main staple items (Eka, 1984). Alcoholic

Food Chemistry 0308-8146/89/$03·50

beverages are produced by fermentation processes from fruits, grains and sap (juice) collected from trees. Palm wine is a fermented beverage produced from palm juice in the southern part of Nigeria (Bassir, 1962). This fast-fermenting juice, obtained from palm trees, is highly unstable and readily develops off-flavour, thereby confining its distribution to the locality of production. It is a popular drink at social activities especially among people of low socio-economic status. It is also cheaper than alcoholic beverages brewed from malted grains. Effort to popularize the consumption of palm juice throughout the country has led to industrial preservation (bottling) of palm juice by indigenous companies.

Subclinical riboflavin deficiency is a common nutritional problem in Nigeria (Ajayi, 1984; Ajayi & James, 1984) attributed to marginal dietary riboflavin, hence, any loss in riboflavin content during food processing or storage is viewed with great concern. This study, therefore, monitors the changes that occur in riboflavin content during processing of palm juice and possible ways of improving its nutritional value.

MATERIALS AND METHODS

Processing practices at three plants which bottle palm juice from oil palm (*Elaeis guineensis*) and raphia palms (*Raphia hookeri, Raphia vinifera*) were studied. Samples (100 ml aliquots) were taken at each stage of processing and conveyed in crushed ice to the laboratory. Three stages of processing were identified—filtration, preservation with sodium metabisulphite and pasteurization. The palm juice was collected around 7 am from palm trees on plantations owned by the processing plant or from scattered palm trees and delivered to the processing plant around 11 am. The sucrose content of palm juice collected was checked with a refractometer to maintain a sucrose content between 4·5 and 6 g/100 ml.

Samples reported in this study consisted of both fermenting and non-fermenting (processed) palm juice, which were collected weekly over a period of 2 months in the dry and wet seasons. Four sets of non-fermenting (100 ml aliquots) palm juice were collected weekly during each processing cycle. The first batch of samples was collected after thorough mixing of the pooled palm juice (unfiltered sample). The second batch (filtered) was collected after the palm juice was passed through gauze or cheese cloth (to remove insects, tree fragments, etc.). A third batch of samples was taken after the addition, with mixing, of sodium metabisulphite in granular form (4·5 g to 50 litres of palm juice). A fourth batch of samples was taken after pasteurization at a holding temperature between 72°C and 78°C for 60 min.

Part of the samples to be processed was dispensed into containers (green

bottles, brown bottles and gourd) and left exposed to atmospheric temperature for 8–10 h (fermenting palm juice). Pasteurized samples from the processed batch were similarly exposed to atmospheric temperature or stored in a dark laboratory cupboard for 6 weeks.

The riboflavin content of samples collected was determined by the fluorometric method of the Association of Official Analytical Chemists (AOAC, 1980).

RESULTS

The riboflavin content of palm juice obtained at different stages of processing is presented in Table 1. Losses in riboflavin content occurred at every stage of processing (from filtration through pasteurization). Although the initial riboflavin content of samples processed was similar from one processing plant to another, the riboflavin content of the juice varied with the type of palm tree from which the juice was extracted. The palm juice from raphia palms has significantly lower ($P < 0.01$) riboflavin content than juice obtained from oil palm trees.

During processing of the palm juice, losses in riboflavin content ranged between 20 and 46% of the initial value. The pasteurized samples contained about 60% of the initial value. The riboflavin content of fermenting palm

TABLE 1
Riboflavin Content (μg/100 ml) of Processed Palm Juice from Three Processing Plants[a]

Processing plant	*Type of palm tree*	*Fresh sample*	*Filtered sample*	*Filtered sample + sodium meta-bisulphite*	*Pasteurized sample*
A (Ife)	Oil palm (Emu)	13·8 ± 0·74 (12·6–14·7)	10·9 ± 0·48 (10·2–11·7)	9·3 ± 0·30 (8·9–9·8)	8·0 ± 0·38 (7·5–8·8)
B (Olumo)	Oil palm (Emu)	14·2 ± 0·40 (13·7–14·8)	10·9 ± 0·28 (10·6–11·4)	9·9 ± 0·35 (9·5–10·4)	8·5 ± 0·28 (8·2–9·0)
	Raphia palm (Oguro)	9·3 ± 0·38 (8·7–9·9)	6·6 ± 0·36 (6·3–7·2)	6·0 ± 0·32 (5·5–6·4)	5·0 ± 0·28 (4·6–5·4)
C (Oshodi)	Raphia palm (Oguro)	8·5 ± 0·20 (8·3–8·8)	6·1 ± 0·33 (5·6–6·6)	5·5 ± 0·21 (5·3–5·9)	4·7 ± 0·21 (4·5–5·1)

[a] Twelve samples from each plant were analyzed.

TABLE 2
Changes in Riboflavin Content (μg/100 ml) of 'Fermenting' and 'Non-Fermenting' Palm Juice Exposed to Atmospheric Temperature

Container	*Time of exposure (h)*[a]					
	Fermenting juice			*Non-fermenting juice (pasteurized)*		
	0	*6*	*8–10*	*0*	*6*	*8–10*
Gourd	11·9 ± 0·28	20·0 ± 0·42	22·0 ± 0·31	—	—	—
Green bottle	12·3 ± 0·35	22·0 ± 0·26	25·0 ± 0·20	8·3 ± 0·20	7·8 ± 0·21	7·5 ± 0·16
Brown bottle	12·1 ± 0·31	20·0 ± 0·35	25·4 ± 0·21	8·0 ± 0·16	7·5 ± 0·21	7·0 ± 0·14

[a] Six samples of each container were studied.

juice (Table 2) increased progressively with time of exposure (range 85–110% increase). On the other hand, the riboflavin content of pasteurized samples exposed to atmospheric temperature showed a decrease ranging from 10 to 31%.

The riboflavin content of the samples studied also varied with the season (Table 3). Palm juice processed in the wet season had a significantly higher ($P < 0·01$) riboflavin content than samples processed in the dry season. Likewise, riboflavin lost during processing was slightly higher for samples processed in the dry than in the rainy (wet) season. However, the riboflavin content of pasteurized samples stored in a dark laboratory cupboard for 6 weeks remained unchanged (Table 3).

TABLE 3
Seasonal Changes in Riboflavin Content (μg/100 ml) of Palm Juice During Processing

Processing plant	*Season dry*	*Number of samples*	*Untreated*	*Filtration*	*Filtration + meta-bisulphite*	*Pasteur-ization*	*Pasteur-ization + storage*
Olumo	Dry	12	12·3 ± 1·23	9·2 ± 0·82	8·0 ± 0·61	7·0 ± 0·50	
(Oil palm			(11·0–14·6)	(8·0–10·0)	(7·4–9·4)	(6·5–7·8)	
—Emu)	Wet	16	13·8 ± 1·00	10·7 ± 0·68	9·6 ± 0·71	8·9 ± 0·58	8·7 ± 0·53
			(12·8–15·6)	(9·4–11·3)	(8·9–11·1)	(7·8–9·5)	(7·8–9·3)
Olumo	Dry	12	6·0 ± 0·19	4·7 ± 0·28	4·1 ± 0·29	3·5 ± 0·22	
(Raphia palm			(5·8–6·4)	(4·0–4·9)	(3·6–4·6)	(3·2–3·9)	
—Oguro)	Wet	16	7·0 ± 0·25	5·6 ± 0·23	4·9 ± 0·25	4·4 ± 0·24	3·1 ± 0·17
			(6·6–7·3)	(5·4–6·0)	(4·7–5·3)	(3·9–4·6)	(2·9–3·3)

DISCUSSION

About 40% of the initial riboflavin content of palm juice was lost during processing. Half of this amount was lost after the filtration stage. Such a high loss during filtration stage could be attributed to the removal of some microorganisms (needed for fermentation) along with plant debris and insects. On the other hand, loss in riboflavin content was similar after the addition of antimicrobial agent (sodium metabisulphite) and after pasteurization. Hence, the pasteurized sample had about 60% of the initial riboflavin concentration.

The season during which processing occurred also influenced the riboflavin content of the finished product. For example, the palm juice processed in the rainy season contained more riboflavin than samples processed in the dry season. This finding is in opposition to the report of Bassir (1968) which stated that the sugar content is lower in palm juice obtained in the rainy than in the dry season. According to Bassir (1968), one would expect less riboflavin because of less fermentative activity as a consequence of lower sugar content in the rainy than in the dry season. Since the initial sucrose content of the processed samples was relatively constant, the lower riboflavin content observed for samples processed in the dry season may be due to irreversible decomposition of riboflavin in bright sunlight (Sattar & de Man, 1973). In the dry season, samples were generally exposed to greater light intensity (direct rays of the sun) during processing than in the rainy season. This assertion is confirmed from data obtained from pasteurized samples exposed to atmospheric temperature or stored in the 'dark' for 6 weeks (Tables 2 and 3). On the other hand, riboflavin content of 'fermenting' palm juice increased substantially when exposed to atmospheric temperature.

Both the concentration of sodium metabisulphite and the pasteurization process seemed adequate to suppress microbial activity because riboflavin content of pasteurized samples remained unchanged after storage in the 'dark' for 6 weeks. This observation confirmed the report of Okafor (1975) that pasteurization at 70°C for 30 min eliminated all yeasts. The pasteurization time in the present study was extended to 60 min, a time interval sufficient to kill or inactivate all microorganisms present.

It is evident from the data obtained that the technique currently used in processing non-fermenting palm juice resulted in significant losses in riboflavin content. However, palm juice of greater nutritional benefit may be obtained if freshly drawn palm juice is allowed to ferment for 10–12 h before processing. As an alternative, processed palm juice may be fortified with riboflavin at the pasteurization stage.

ACKNOWLEDGEMENT

Appreciation is extended to the Managers and workers of the processing plants for granting us access to the plants and for the invaluable assistance rendered.

REFERENCES

Ajayi, O. A. (1984). Biochemical ariboflavinosis among Nigerian rural school children. *Hum. Nutr. Clin. Nutr.*, **36C**, 71–9.

Ajayi, O. A. & James, O. A. (1984). Effect of riboflavin supplementation on riboflavin nutrition of a secondary school population in Nigeria. *Am. J. Clin. Nutr.*, **39**, 787–91.

Andah, A. & Muller, H. G. (1973). Studies on 'Koko' a Ghanaian fermented maize porridge. *Ghana J. Agric. Sci.*, **6**, 103–8.

AOAC (1980). *Official Methods of Analysis.* (13th edn), Association of Official Analytical Chemists, Washington, DC, pp. 740–3.

Bassir, O. (1962). Observations on the fermentation of palm wine. *W. Africa J. Biol. Appl. Chem.*, **6**, 20–5.

Bassir, O. (1968). Some Nigerian wines. *W. Afr. J. Biol. Appl. Chem.*, **10**, 42–5.

Eka, O. U. (1984). A review of studies on changes in nutrient composition during fermentation. *Nig. J. Nutr. Sci.*, **5**, 9–21.

Okafor, N. (1975). Preliminary microbiological studies on the preservation of palm wine. *J. Appl. Bact.*, **38**, 1–7.

Sattar, A. & deMan, J. M. (1973). Effect of packaging material on light-induced quality deterioration of milk. *Can. Inst. Food Sci. & Tech. J.*, **6**, 170–4.

Van Veen A. C. & Steinkraus, K. H. (1970). Nutritive value and wholesomeness of fermented foods. *J. Agric. Fd. Chem.*, **18**, 576–8.