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Full Length Research Paper

Studies on the chemical composition and storage parameters of sun-dried Kola nuts

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Kola nuts (*Cola nitida*) were sun dried to determine their storage and suitability parameters for possible export. Moisture content of nuts could be reduced to 7 - 9% by sun-drying in wooden trays with raffia mat bases. Milled nuts stored for 12 months in sealed polybags at room temperature (25 - 27°C) did not significantly (*P* 0.05) absorb moisture over the period of storage. The chemical composition of most of the non-volatile components (protein, fibre, ash, non-soluble sugars, caffeine, lipids, potassium and total nitrogen) in the sun-dried nuts did not significantly differ from that of the fresh and cured nuts. There were, however, significant differences in soluble sugars and total polyphenols. Other differences observed were in the volatile profile of the nuts taken through various treatments. The implications of the result are discussed.

Key words: *Cola nitida*, cured nuts and caffeine.

INTRODUCTION

Most cola pickers, traders and industrial users depend on the traditional way of curing and preserving the nut, which lead to substantial losses by way of insect infestation (Owusu-Manu and Mama, 1995; Owusu-Manu and Bonku, 1994), *in-situ* germination, shrinkage, bolting and mouldiness (Adenikinju et al., 1989). Such losses can be avoided with the use of proper storage containers, proper pre- and post- storage insect control strategies and periodic turning of the nuts in storage. Discarded kola nuts are an economic loss to the farmer for lack of effective processing of such nuts. But with proper integration of sun drying of both insect infested and whole nuts, good curing and control of post harvest losses during curing / storage, the farmer can increase his income substantially. The industrialist can also benefit from the otherwise lost raw material and the possible high levels of caffeine/ theobromine which can be obtained through sun-drying of nuts for industrial use.

This paper discusses the changes in the mineral content, caffeine, crude protein and volatile aroma substances in kola nut compared to those in the traditional curing process.

MATERIALS AND METHODS

The experiments were carried out at the Cocoa Research Institute of Ghana (CRIG), Tafo. Freshly harvested *Cola nitida* nuts were depulped and divided into eight equal lots of approximately 5 kg. Nuts were sun-dried for four weeks at ambient day temperature of 32ºC in wooden trays. Weight of nuts was monitored until they were completely dried. Samples were then milled in a commercial mill, stored in polybags at room temperature and sampled once a month for 12 months for moisture determination. Another set of four, each consisting of 200 nuts, was taken through the curing process for 6 months using baskets lined with banana leaves.

The factors investigated were effect of sun drying and curing on the caffeine, volatile components, total nitrogen and mineral nutrients of the nuts. The dry weight of the samples was determined in triplicate by the method of Association of Analytical Chemist (A.O.A.C, 1990). Aroma volatile extraction was done using the Likens-Nickerson concurrent steam distillation- solvent extraction technique and analysed by gas chromatography with FID detector (AMS model 93), as modified by Tomlins (1993). Injector and detector temperatures were set at 220° and 250°C respectively. Carbowax 20 M (25 m x 0.32 mm id) column was used under the temperature programme 60°C for 5 min, gradient to 240°C at 4°C/min, followed by isothermal for 30 min. Nitrogen was used as the carrier gas at 1.5ml/min. A splitless injection of 5 l was done.

Total ash, crude fibre, total lipid content and total nitrogen were determined by the method of A.O.A.C (1990). Crude protein content was then calculated from total nitrogen (N x 6.25). Caffeine content was determined by HPLC with some modifications using the methods from literature (Anon, 1990). To 0.200 g of sample in a weighed 250 ml round-bottomed flask was added 95 ml distilled water and refluxed for 25 min. After cooling, weight of water added was adjusted to 100 g, thoroughly shaken and centrifuged for 5 min at 5000 rpm to obtain a supernatant. Prior to analysis, the extracts were filtered through a 0.45 µm Millex filter (SLHV013SL, Millipore, Carrigtwahill, Ireland). The HPLC system comprised a Cecil 1100

Table 1. Chemical composition of *Cola nitida* nuts after various treatments.

Constituents (%)	Fresh nuts[1]	Cured nuts[2]	Sun dried nuts[3]	Stored dried nuts[4]
Ash	2.69 ± 0.2	2.91 ± 0.3	2.67 ± 0.2	2.71 ± 0.4
Lipid	0.81 ± 0.02	0.90 ± 0.1	0.80 ± 0.2	0.77 ± 0.3
Crude protein (N x 6.25)	8.00 ± 0.60	9.00 ± 0.3	8.04 ± 0.6	7.85 ± 0.9
Nitrogen free extract	85.61 ± 1.4	84.11 ± 0.5	85.73 ± 1.1	85.40 ± 0.9
Caffeine	1.42 ± 0.4	2.05 ± 0.5	1.56 ± 0.4	2.4 ± 0.6
Total Nitrogen	1.28 ± 0.1	1.41 ± 0.4	1.29 ± 0.3	1.31 ± 0.2
Crude fibre	2.89 ± 0.35	2.72 ± 0.5	2.76 ± 0.4	2.80 ± 0.6
Soluble sugars	1.10 ± 0.1[a]	0.15 ± 0.03[b]	0.9 ± 0.2[a]	0.5 ± 0.3[a]
Non soluble sugars	25.2 ± 0.7	26.5 ± 1.0	27.0 ± 1.5	26.9 ± 0.9
Total Polyphenols	6.5 ± 0.1 [a]	5.3 ± 0.2 [b]	3.7 ± 0.1 [c]	3.4 ± 0.3 [c]
Potassium	1.04 ± 0.2	1.06 ± 0.1	1.02 ± 0.2	1.01 ± 0.3
Phosphorus	0.19 ± 0.02	0.21 ± 0.04	0.23 ± 0.03	0.20 ± 0.03
Moisture content	72.80 ± 4.0 [a]	47.9 ± 1.5 [b]	8.05 ± 2.1 [c]	8.15 ± 1.5 [c]

In all the tables, figures in a roll with the same letter are not significantly different at *P* 0.05. Compositional data are given on a dry mass basis (dmb).
[1]Fresh nuts – raw nuts
[2]Cured nuts – cured for 6 months
[3]Sun-dried nuts – sun-dried for 40 days
[4]Milled & stored – sundried nuts milled and stored for 12 months

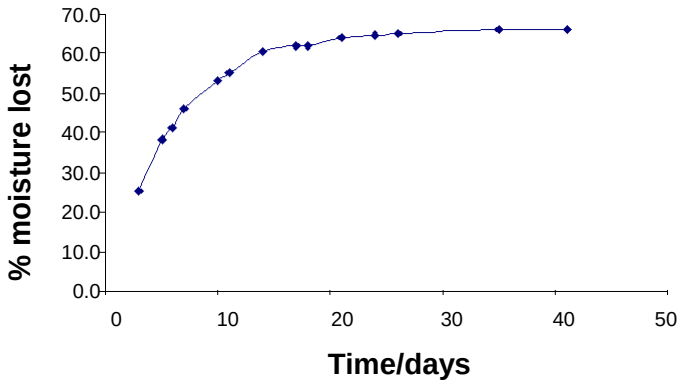

Figure 1. Rate of sun drying of *Cola nitida* nuts at 32 ± 5°C.

binary HPLC pumps fitted with a 20µl sample loop and a Cecil 1200 variable wavelength detector set at 280 nm. A Hypersil ODS C18 column (25 cm x 4.6 mm) fitted with a guard column (H5ODS-1521A, HICHROM Ltd) was used to achieve the chromatographic separations. Compounds were eluted with an isocratic mobile phase of methanol: acetic acid: water (20: 1: 79; HPLC grade) at a flow rate of 1ml/min at 25ºC.

The methanol (80%) soluble phenolics were estimated as adopted by Amorim et al. (1974) with catechin as standard. Potassium and phosphorus determinations were made as described by Chapman and Pratt, (1961). 1 g of dried sample was digested with two batches of 5 ml concentrated $HN0_3$, followed by 5 ml of 60% perchloric acid. The salts from the $HN0_3$ were dissolved in 2 ml $HN0_3$ after cooling and made to 100 ml in a volumetric flask with de-ionised water. Samples were analysed on a SpectraAA 20 Atomic absorption spectrometer (Varian pty limited, Australia) and Phosphorus determined following the procedure of Chapman and Pratt (1961).

The analysis for sugars was done following the procedure of Dubios et al. (1956). Statistical analyses of data were done using the R statistical package version 1.9.0 *(*R Development Core Team, 2004) and contrasts used to separate differences between treatment means with significance of *P* 0.05.

RESULTS AND DISCUSSION

The initial moisture content of the fresh kola nuts ranged from 68.8 to 74.8%. Nuts cured for six months, sun- dried nuts, milled and stored sun -dried nuts were found to have moisture contents of 47.9 ± 1.5, 8.05 ± 2.1 and 8.15 ± 1.5%, respectively. Percentage total moisture loss for the first ten days ranged from 55 to 58% of the original mois-ture content. Figure 1 indicates that the drying rate of kola nuts followed the form a hyperbola, that is, an initial increasing drying rate-period (day1 to 9) followed by a nearly constant drying rate-period, with drying effectively completed within 14 days.

Table 1 shows the chemical composition of the non volatile components. The total polyphenols were found to be significantly higher in the fresh nuts compared to the cured and sun-dried nuts. This could be explained by the fact that a fraction of phenolic compounds compacted into vacuoles of specific cells might have leached out dur-ing curing/fermentation. Polyphenol reduction during dry-ing could have resulted from enzymatic degradation fol-lowed by non-enzymatic browning to form quinone deri-vatives as reported for cocoa (Roelofsen, 1958). The soluble sugars were significantly lower (P 0.5) in the cu-red nuts compared to the fresh and sun-dried nuts. This could partly be explained by sugar metabolism by nut respiration during curing/fermentation. Analysis of varian-

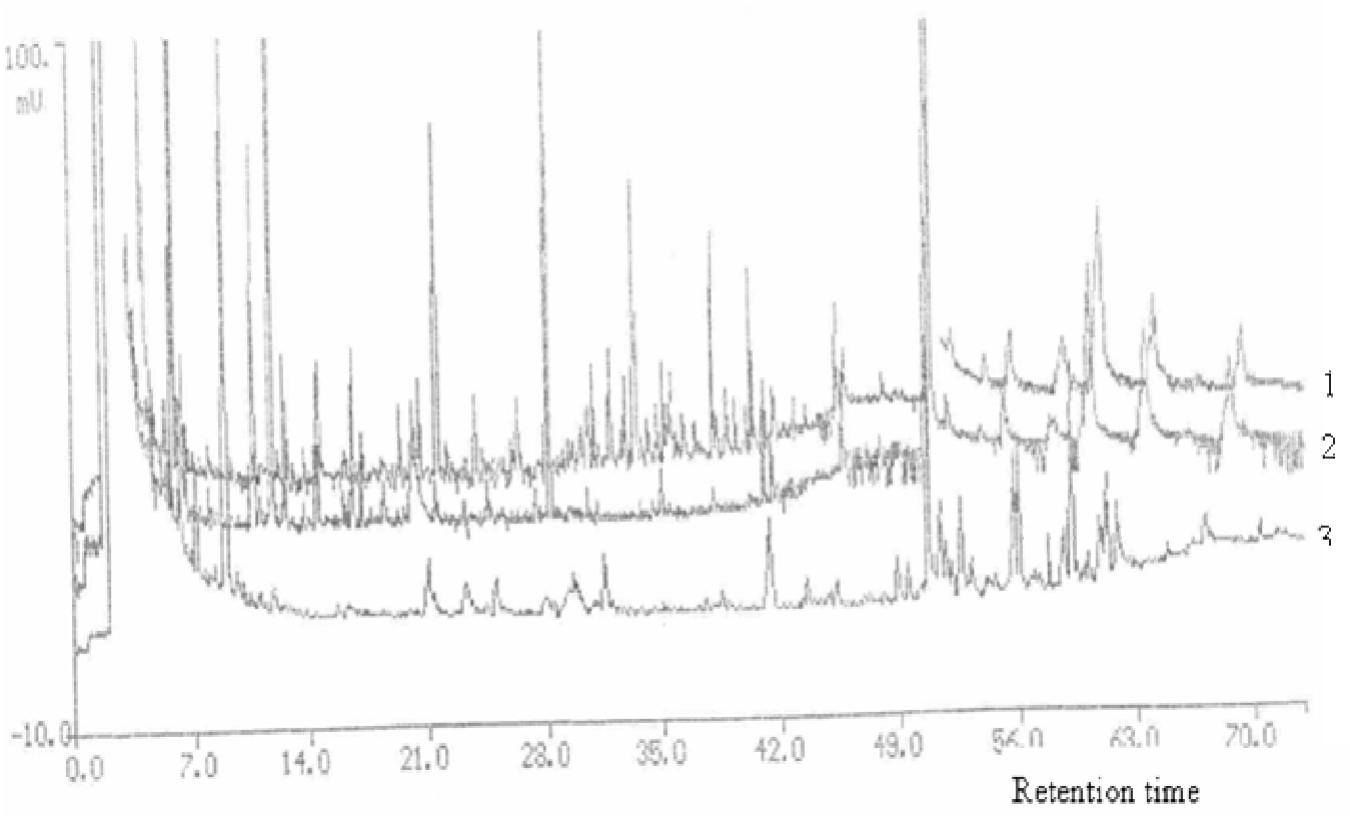

Figure 2. Chromatograph of volatile aroma substances in 1. cured nut 2. Fresh nut and 3. sun-dried nut.

ce on the data obtained on the crude protein, non soluble sugar components, caffeine, crude fibre, nitrogen, potassium, phosphorus, ash and lipid components did not indicate any significant differences between the treatments in these parameters. Results so far indicate the possibility of sun-drying kola as a complementary treatment to nuts cured for export. Thus, sun-dried kola can technically be used like cured kola for caffeine and dye extraction. The advantages of sun-drying are realised in the fast drying step which eliminates the stage where most nuts were lost during curing through insect damage.

The relatively high crude protein, ash and mineral content also suggest the possibility of incorporating it as a feed supplement for animals after depurination.

Differences were observed in the aroma substances between sun-dried, fresh and cured nuts as illustrated in Figure 2. The chromatogram indicates the loss of some aroma substances during sun drying. This is illustrated by the difference in peaks between time 14 and 49 min. The differences between the cured and the fresh nuts (14 – 19 min) may suggest the formation of certain volatile aroma substances during the curing/fermentation process.

Conclusion

Kola nuts could be sun dried on wooden trays with raffia palm based mat, milled and stored in sealed rubber bags over a period of twelve months with no changes in most quality parameters required for industrial processing.

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