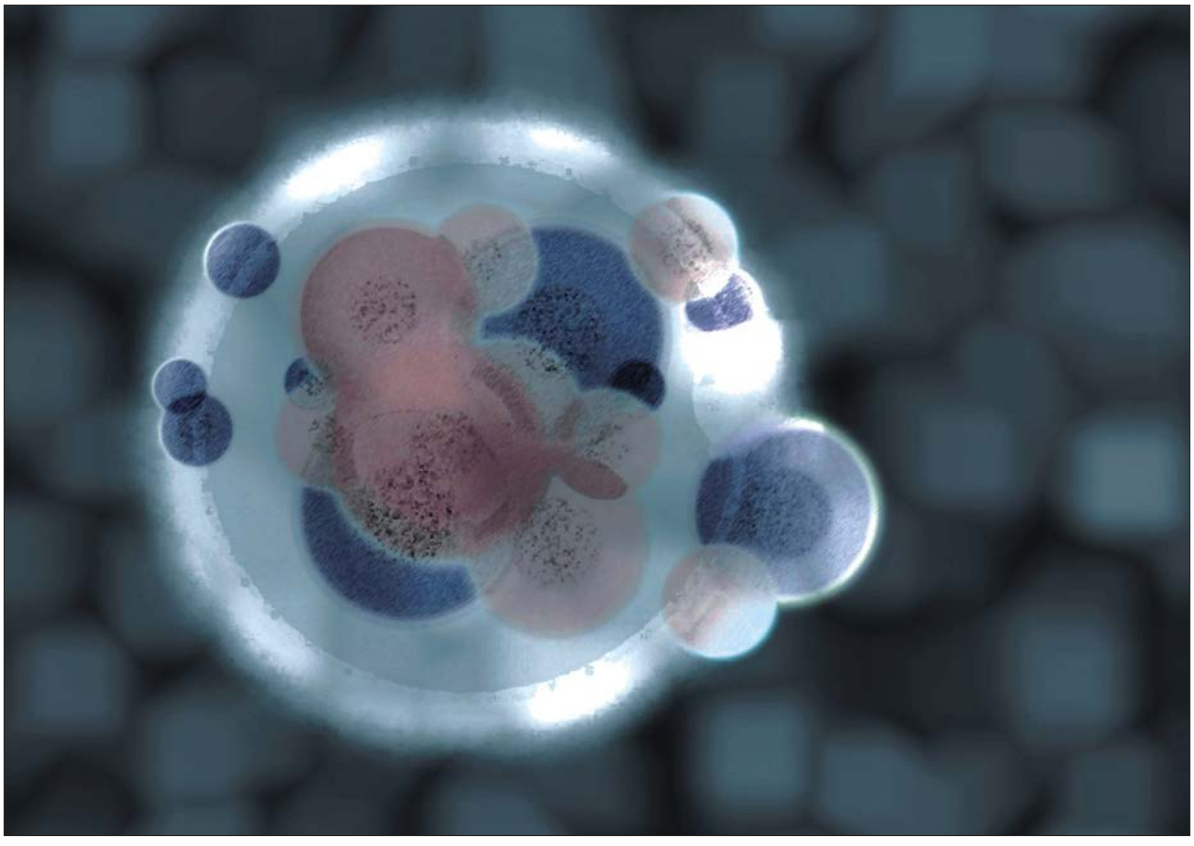

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Effect of Drying Pre-Treatment and Drying Density on Ghanaian Robusta Green Coffee Quality

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Abstract: Analysis on the free sugars, methanol soluble phenolics, pH and the total chlorogenic acid (CGA) were carried out on green coffee beans stored (0-4 days after harvesting) in jute sacks before drying on raised platform at three density levels (20, 30 and 40 kg m^{-2}). Storage of green beans in sacks before drying was found to significantly affect the levels of soluble sugars, chlorogenic acids and pH of the green coffee beans but not the free phenolics. The soluble sugars and pH were generally higher in the control (zero day storage) and the reverse was true for chlorogenic acids. Their implication for dry processing of coffee beans is discussed.

Key words: Chlorogenic acid, soluble sugars, pH, green coffee beans, phenolics

INTRODUCTION

Robusta coffee beans for export in Ghana are generally dry-processed by drying the fresh berries on raised platforms immediately after harvesting. Weather conditions, distance of farm to drying sites and other logistic constraints could, however, cause delays between harvesting and drying. Re-wetting, condensation, fermentation and possibly mould growth could be some of the consequences of delays in drying freshly harvested coffee (Amorin *et al*., 1974a), which could adversely affect the cup quality of coffee produced in Ghana. Information on the non-volatile components of the green coffee beans as affected by pre-drying storage conditions and their effect on the final quality of the dried beans is limited in the literature. Interest in chlorogenic acids (CGA) and related compounds in the green and roasted coffee have been growing because of their antioxidant properties and perceived benefits for the consumer (Hofmann and Somoza, 2004; Stewart and Crozier, 2004). Levels of CGA in coffee seed vary and change with maturity (Clifford, 1985a), species (Clifford *et al*., 1989), steaming, roasting and the method of processing (Macrae *et al*., 1987). Dry processing of robusta has for example, been reported to result in lower chlorogenic acid content compared to enzyme accelerated wet-processed beans (highest content) and intermediate for traditionally wet processed beans (Guyot *et al*., 1995). Astringent beverage has been suggested to be associated with green beans with high CGA content (Clifford, 1985b). The total chlorogenic acid (CGA), pH, total phenolics and ethanol soluble sugars in the robusta coffee taken through four pre-drying treatments and a control at three drying densities with regard to the levels of five perceived indirect quality parameters were determined in this study.

MATERIALS AND METHODS

The experiment was carried out in 2005/2006 at the Cocoa Research Institute of Ghana (CRIG), Tafo. Freshly harvested robusta green coffee beans from three research plots were bulked, mixed thoroughly and sub samples taken and used in a completely randomised design with three replicates. The factors investigated were green bean stored in jute sacks at room temperature for either-one day (T_1), two days (T_2), three days (T_3) or four days (T_4) before drying on raised platforms of raffia mat at three density levels (20, 30 and 40 kg m^{-2}). These were compared with coffee put on drying mats shortly after harvesting without storage (TO). The green coffee was dried for 6 weeks at ambient temperature of 32/23°C, day/night with periodic stirring with a wooden rake during the day. The coffee was covered with raffia mat from the evening to the morning or whenever there were signs of rain.

The dry weight of the samples were determined after the drying period and sub samples taken for biochemical analysis following the method of the Association of Analytical Chemist (AOAC, 2005).

The total chlorogenic acid was estimated following the method of Moores *et al*. (1948). The standard curve was prepared using chlorogenic acid at concentrations 20, 40, 60, 80 and 100 ppm.

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The methanol (79+1% HCl) soluble phenolics were estimated as adopted by Amorim *et al.* (1974b). The calibration curve was obtained using catechin.

The analysis for soluble sugars in 80% ethanol was done following the procedure of Dubios *et al.* (1956) and adopted by Amorin *et al.* (1974b).

The method for the pH determination was that of Office International du Cacao et du Chocolat. Ten grams of ground coffee was extracted with 90 mL boiling de-ionised water. The coffee was extracted for 10 min, cooled to 25°C and the pH determined using a Mettler-Toledo pH meter equipped with a standard single-junction glass-Ag/AgCl combination electrode, which was calibrated at pH 4, 7 and 9.

Statistical analyses were done using the R Foundation for Statistical Computing programme (version 1.9.1). Analysis of variance was used to evaluate the effects of the storage treatments on the perceived quality factors. The significance of the mean difference was tested using R-contrast when the significance of the storage treatment effect was = 0.05.

RESULTS AND DISCUSSION

The level of CGA was found to be significantly higher in all the storage treatments compared to the control. The maximum occurred in seeds stored for three days before drying (Table 1). It is not certain if any biochemical reactions taking place during the storage results in the conversion of one form of CGA to another and other substrates to CGA.

The density of drying did not significantly affect the levels of CGA (Table 1). Very high CGA content of beans is associated with astringent beverages (Clifford, 1985b) and poor quality coffee from Brazil has been reported to contain very high total chlorogenic acids. Thirty percent of chlorogenic acids are known to decompose in the roasting process with the decomposition products found in coffee aroma. A delay in the drying process (different from the standard recommended method) that either reduces or increases the CGA in the green beans as observed in this study is likely to impart on the quality and desirability of the processed beans.

No significant differences in the total methanol soluble phenolics were observed between all the treatments and control at the three drying densities. The result shows that the amount of free phenolics present in the harvested beans was not affected by the post harvest treatments imposed. It is however uncertain if biochemical reactions could cause the conversion of one form of phenolics into another.

The data obtained on the soluble sugars and pH in the coffee beans taken through the storage treatments and drying at the three densities is shown in Table 2.

The level of soluble sugar in the control was significantly higher ($p = 0.05$) than all the storage treatments. This could be attributed to the fact that coffee seeds go on living even after harvest and like all living organisms consume sugars to produce energy along with carbon dioxide and water during breathing. A possible rise of temperature in the sacks during storage could also accelerate breathing and hence the longer the beans were stored as seen in T_4, the less the amount of soluble sugar present. The pH of the control treatment was found to be significantly higher ($p = 0.05$) than all the treatments, suggesting that delays in drying coffee after harvesting could increase the acidity and hence make the coffee more astringent. The various densities of drying however did not significantly affect ($p = 0.05$) the pH of the dried beans. The results indicate that a days' delay in drying could affect the acidity (pH) of the green coffee bean and subsequently the quality of the coffee. The extent to which these changes in acidity, free sugars and CGA levels would persist to the cup however remains to be tested.

Table 1: The effect of pre-drying storage treatment and density of drying on percentage chlorogenic acid and soluble phenolics in coffee beans

Treatments	Drying density (kg fresh coffee m^{-2})	Chlorogenic acids	Soluble phenolics
Zero day storage	20	3.69±0.03a	2.07±0.76
before drying (Control)	30	3.49±0.06a	2.20±0.61
	40	3.57±0.13a	1.42±0.20
One day storage before	20	5.81±0.86b	1.48±0.33
drying (T_1)	30	6.53±0.11b	1.53±0.05
	40	6.18±0.27b	1.58±0.25
Two days storage before	20	6.14±0.49c	1.44±0.34
Drying (T_2)	30	6.56±0.16c	1.64±0.08
	40	6.22±0.51c	1.33±0.46
Three days storage before	20	6.44±0.41d	1.86±0.22
drying (T_3)	30	6.27±0.14d	1.89±0.06
	40	6.67±0.56d	1.94±0.26
Four days storage before	20	4.24±0.67e	1.79±0.26
drying (T_4)	30	3.71±0.22e	1.76±0.23
	40	3.68±0.07e	1.65±0.11

Values in a column with the same letter(s) are not significantly different at $p = 0.05$, Compositional data are given on a dry mass basis (dmb)

Table 2: The effect of pre-drying storage treatment and density of drying on percentage soluble Sugars and pH of coffee beans

Treatments	Drying density (kg fresh coffee m^{-2})	pH	Soluble sugars (%)
Zero day storage	20	6.14±0.11b	2.29±0.76a
before drying (Control)	30	6.12±0.05b	2.23±0.87a
	40	6.21±0.12b	2.12±0.42a
One day storage before	20	6.00±0.06a	1.15±0.24bd
drying (T_1)	30	6.07±0.13a	1.47±0.25bd
	40	6.06±0.07a	1.58±0.29bd
Two days storage before	20	6.06±0.02a	1.63±0.41cb
drying (T_2)	30	5.96±0.03a	1.68±0.08cb
	40	6.04±0.06a	1.65±0.26cb
Three days storage before	20	6.12±0.09a	1.43±0.26cd
drying (T_3)	30	6.29±0.18a	1.44±0.06cd
	40	6.14±0.25a	1.48±0.11cd
Four days storage before	20	6.06±0.03a	0.44±0.14e
drying (T_4)	30	6.10±0.07a	0.44±0.04e
	40	6.05±0.02a	0.40±0.02e

Values in a column with the same letter(s) are not significantly different at p = 0.05, Compositional data are given on a dry mass basis (dmb)

CONCLUSION

Based on the results of this study, it is concluded that changes in the non-volatile components (total CGA, free sugars and pH) occurred in the green coffee beans because of the storage methods imposed before the drying process but not the three densities used. As to whether these changes are significant enough to constitute off notes and taints that would persist to the cup level should be of concern to cultivators and processors.

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