Nigerian Food Journal
Official Journal of Nigerian Institute of Food Science and Techonology www.nifst.org
NIFOJ Vol. 30 No. 1, pages 26 – 34, 2012

Changes in some Physicochemical Properties of *Cassia sieberiana* Seeds During Roasting

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ABSTRACT

One of the uses of *Cassia sieberiana* seeds is roasting for beverage. Therefore, the thrust of this work was to study changes in some physicochemical properties of *Cassia sieberiana* seeds during roasting. A 3 x 3 factorial experimental design was employed. Roasting temperatures were 190, 210 and 230°C while roasting times were 10, 20 and 30 min respectively. Nine experimental combinations were produced. Proximate composition of unroasted sample, pH, total soluble solid, total titratable acidity, acetic acid, weight loss, caffeine content, swelling and colour of both unroasted and roasted samples were determined using standard methods. Proximate composition of unroasted *Cassia sieberiana* in percentage as determined were moisture content (9.04 ± 0.04), ash (9.3 ± 0.03), crude fibre (16.21 ± 0.09), crude protein (19.88 ± 0.03), fat (5.31 ± 0.05) and carbohydrate (40.26 ± 0.33). The pH, total soluble solid, total titratable acidity, acetic acid, caffeine content and colour of unroasted *Cassia sieberiana* seed were 6.25 ± 0.7, 3.0 ± 0.13 (°O), 0.57 ± 0.06 (mg/g), 0.12 ± 0.00 (%), 11.6 ± 1.05 (%) and 0.43 abs respectively. Effect of roasting was significant ($p < 0.05$) on moisture content, weight loss, caffeine content, swelling and colour, while a non-significant ($p > 0.05$) effect was recorded on pH, total soluble solid, total titratable acidity and acetic acid.

Keywords: *Cassia sieberiana*, roasting temperature, roasting duration, proximate composition, physical properties.

Introduction

Cassia sieberiana is a relatively unknown African plant species regarded as weed. It is a member of the family Caesalpiniaceae (Toma *et al.*, 2009). It grows like many other weeds until recently when attention is being shifted to it by researchers that collect it to determine its usefulness. *Cassia sieberiana* is found in most parts of Nigeria and its indigenous names include *marga* among the Hausa, *margaje* by the Fulani and *ifo* by the Yoruba (Toma *et al.*, 2009).

Some of the uses of the crop include cooking of leaf for herb, eating of sweet extract from stem and roasting of seed for beverage (Mortimore, 2010). The fruit is without longitudinal septum and contains about 10 – 20 seeds. Average length, diameter and thickness of the seeds are 4.65, 3.85, and 1.5 mm respectively. Characteristic colours of the seed are brown and grey.

Primary processing of *Cassia sieberiana* seeds involves cleaning, roasting and milling. Roasting is known to influence physical, chemical and functional properties of crops (FAO, 2003). This unit operation promotes thermal degradation of chemical components of food materials. Roasting is generally accompanied with caramelization of sugar polysacharides and Maillard reactions of reducing carbohydrates and protein contents of the food materials. Roasting generates characteristic flavour and colour which consumers require for acceptance (Olapade and Akinoso, 2004). Appearance, volatile acids, non-volatile acids, oil, protein and carbohydrate of crops depends on roasting conditions (McGee, 2004). These parameters are important to the production of the end product. Optimum roasting condition is a function of use,

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type of process employed, moisture content, size and shape, wholesomeness, botanical variety and maturity of seeds (Olapade and Akinoso, 2004). Some reported works on *Cassia sieberiana* seeds include determination of proximate composition (Amubode and Fetuga, 1983) and determination of amino acid composition (Amubode and Fetuga, 1984). Roasting time, the air temperature used, the means of heat conveyance (radiant, conduction, or convection), the mean and rate of cooling, all have impact on the product value. Quality is one of the major factors determining the uses and application of food materials. Therefore, the thrust of this work was to study changes in some physicochemical properties of *Cassia sieberiana* seeds during roasting.

Materials and Methods

Cassia sieberiana pods were harvested from the University of Ibadan farm in Ajibode. The pods were split open and the seeds were removed, air dried for 3 days, then winnowed of the impurities and stored in low density polyethylene bag for subsequent use. Moisture content, ash, crude fibre, crude protein, fat, and carbohydrate of untreated *Cassia sieberiana* were determined using standard methods. Methodologies adopted were ASABE S410.1 method for moisture content, (ASABE, 2008); AOAC 950.49 method for ash, AOAC 962.10 method for fibre, AOAC 954.01 for crude protein determination, AOAC 920.39C method for fat, (AOAC, 2005); and carbohydrate by calculation as reported McClements (2003).

Treatments

A 3 x 3 factorial experimental design was employed to carry out the study. Roasting temperatures were 190, 210 and 230°C while roasting time were 10, 20 and 30 min. Nine experimental combinations were produced (Table 1). Roasting of the seed was done in an oven. Temperature stability was achieved by Akinoso (2006) method. The product's initial temperatures were raised to equilibrium with roasting temperature. This was achieved by wrapping them in polythene bags and placing them in oven at desired roasting temperature level. These samples were later heated by spreading thinly on a heat conductor tray in an oven at a preset temperature. Samples of 1 kg each were separately heated in the oven at different temperatures and time combinations. Stopwatch was used to monitor the time. Both untreated and treated samples were separately milled to pass through a 2 mm opening screen. Some physicochemical properties of untreated and treated samples were determined as illustrated below.

Moisture content determination

Moisture content of the granules was determined using ASABE (2008) method. About 2 g of the granules was placed in a Petri dish and heated in an oven at 105°C for 2 h, after which it was removed and cooled in glass jar containing silica gel desiccant for about 15 min. Weight of the Petri dish containing the cooled samples was measured using digital weight balance (ED 2201-CW, Sartorious, Berlin, Germany). The sample was further dried for 30 min cooled and reweighed. This procedure was repeated until a constant weight was observed. The experiment was duplicated for accuracy. Moisture content was calculated using equation 1.

$$\% \text{ moisture content (dry basis)} = \frac{\text{weight of water} \times 100\%}{\text{weight of dry product}} \quad \ldots 1$$

pH determination

pH determination was carried out as described by Afoakwa *et al.* (2006) using the glass electrode TOA pH meter.

Total soluble solids determination

About 2 g of the sample was simmered with 200 ml of boiling water at 100°C for 5 min. After the extract has cooled, the per cent soluble solids were determined using Bausch and Lomb sugar refractometer (AOAC, 2005).

Total titratable acidity determination

About 1g of the granules was extracted with water at 50°C. The acidic solution was titrated with 0.1N NaOH to give end point colour change. Phenolphthalein was used as the indicator. Volume

of acidic solution used was 25 ml. The titratable acidity was calculated using equation 2 (AOAC, 2005).

$$\% TA = \frac{(\text{ml of NaOH}) \times (\text{N of NaOH}) \times (\text{Equivalent Weight})}{10 \times \text{sample weight}} \quad \ldots 2$$

Acetic acid determination

About 25 ml of the titrable acidic solution was evaporated in a water bath to a small bulk. Equal amount of distilled water was added to the content in evaporating basin, and the evaporation was repeated. Another 25 ml of distilled water was added to the small bulk left and titrated against 0.1N NaOH using phenolphthalein indicator. The difference between the titre got for Titratable Acidity and the latter one was recorded as acetic acid using 1 ml of 0.1N NaOH being equivalent to 0.006005 g acetic acid (AOAC, 2005).

Caffeine determination

Crude caffeine contents of the samples were determined by modified method of Mumin *et al.* (2006). Five gram solid sample was placed in 500 ml beaker and subsequently 225 ml distilled water was added to it. The mixture was boiled for 10 min and filtered by using a Buchner Funnel. Ten per cent lead ethanoate solution (25 ml) was added with the filtrate, boiled for 5 min and filtered again. A 500 ml separatory funnel was put into an iron ring on a ring stand. Pouring the sample solution in the separatory funnel and adding 30 ml of $CHCl_3$, the solution was shaken uniformly while the stopcock was opened to expel vapors. The layers were allowed to separate and the lower layer (chloroform) was collected into a 100 ml beaker and the separation procedure was repeated for the second time to collect into the beaker. Anhydrous sodium sulfate was added in the beaker containing the combined extracts. The beaker containing the extracts was then heated a short period for dryness using a water bath and the temperature was controlled low enough at 70 – 90°C to avoid caffeine decomposition. After 24 h, white crude caffeine was deposited at the bottom of the beaker. This was weighed and recorded as percentage of initial sample.

Weight loss determination

Weight loss was determined by measuring the sample weight before and after roasting. Difference in weight was divided by initial weight; obtained value was recorded as the weight loss in percentage (ASABE, 2008).

Swelling determination

Change in size due to roasting was determined using Archimede's principle. Both treated and untreated samples (50 g) were submerged in 100 ml petroleum ether inside a 250 ml measuring cylinder and the volume of the liquid displaced which is equal to the volume of submerged beans was measured. Percentage swelling was calculated using equation 3.

$$\% SW = \frac{\text{initial volume} - \text{final volume}}{\text{initial volume}} \times 100 \quad \ldots 2$$

Colour

The colour of the sample was determined using a spectrophotometer (AOAC, 2005). Mixture of sample and n-hexane was prepared in ratio 1 to 9 ml. This mixture was shaken vigorously, and the absorbance was read at 470 nm on UVIKON XL spectrophotometers (North Star Scientific, Leeds, UK).

Statistical analysis

Three replicates each of the determination roasting were carried out. Mean values were recorded as obtained data. Degree of influence of treatment on moisture content, acidity, total soluble solids, titratable acidity, acetic acid, dry matter loss, caffeine content and swelling of seed was determined by statistical analysis of obtained data from the experiments. ANOVA and regression analysis of the results were carried out using SPSS 13.0 software package. Roasting conditions are independent variables while the determined properties are dependent variables. Interaction between the variables was examined under linear and polynomial to establish appropriate mathematical relationship. Models were developed and the effect of the substitution was considered at 5% level of significance.

Results and Discussion

Chemical properties of unroasted seed

Proximate composition of unroasted *Cassia sieberiana* as determined were moisture content (9.04 ± 0.04), ash (9.3 ± 0.03), crude fibre (16.21 ± 0.09), crude protein (19.88 ± 0.03), fat (5.31 ± 0.05) and carbohydrate (40.26 ± 0.33). The values of pH, total soluble solid, total titrable acidity, acetic acid, caffeine content and colour of unroasted and roasted *Cassia sieberiana* seed are shown in Table 1. The unroasted sample had values of 6.25 ± 0.7, 3.0 ± 0.13(°O), 0.57 ± 0.06 (mg/g), 0.12 ± 0.00 (%), 11.6 ± 1.05 (%) and 0.43 abs for pH, total soluble solid, total titrable acidity, acetic acid, caffeine content and colour respectively as shown in Table 1.

Moisture content

Visual illustration of effect of treatment on moisture content is shown in Figure 1. There was strong negative correlation between moisture content and roasting temperature with a high coefficient of correlation (R^2) (Figure 1). The plot shows that moisture content of the seed decreased with increase in roasting temperature and duration. This might be attributed to rapid vaporization of water at high temperature to the surroundings. Specific heat capacity and thermal conductivity of biomaterial depend on its moisture content (Barbosa-Canovas *et al.*, 2006). Therefore, moisture content is likely to influence quantity of heat required to roast the seed. High moisture content, high specific heat capacity, high thermal conductivity and lower quantity of heat required are for roasting. It is worth noting that moisture content is a parameter determining storage life of crop; the higher the water activity the higher the rate of deterioration.

Table 1: Design matrix and responses

S/N	Temp. (°C)	Time (min)	MC (%db.)	pH	TSS (°O)	TTA (mg/g)	AA (%)	WL (%)	CF (%)	SW (%)	CL (Abs)
G	0	0	9.04	6.25	3.0	0.57	0.12	0.0	11.6	0.00	0.43
1	190	10	3.59	6.06	2.9	0.47	0.06	3.10	10.9	13.6	0.62
2	210	10	3.59	6.05	2.9	0.43	0.04	6.50	10.9	18.2	0.68
3	230	10	3.50	6.03	2.8	0.41	0.04	3.50	10.7	18.2	0.74
4	190	20	3.42	6.03	2.3	0.37	0.04	9.30	10.4	27.3	0.66
5	210	20	3.17	6.03	2.0	0.33	0.02	10.9	10.1	31.8	0.75
6	230	20	3.17	6.41	1.9	0.33	0.02	14.6	9.7	45.5	0.84
7	190	30	3.34	6.03	1.2	0.42	0.00	14.2	9.7	50.0	0.89
8	210	30	2.84	6.34	1.0	0.40	0.00	18.1	9.4	49.5	0.91
9	230	30	3.00	6.48	1.0	0.38	0.00	21.2	8.6	63.6	0.95

Where MC is moisture content, TSS is total soluble solid, TTA is total titratable acidity, AA is acetic acid, WL is weight loss, CF is caffeine, SW swelling and CL is colour.

pH

The pH of the treated seed ranged from 6.48 to 6.03. Mean pH is 6.16 ± 0.18. From Figure 2, increase in pH was observed with increase in roasting temperature. An increase in any solution temperature will cause a decrease in its viscosity and an increase in the mobility of its ions in solution (Zumdahl, 1993). An increase in temperature may

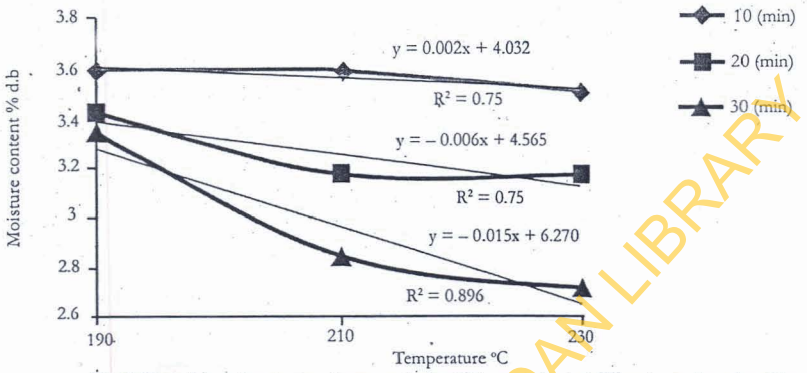

Fig. 1: Plot of roasting temperature against moisture content at different roasting duration

also lead to an increase in the number of ions in solution due to the dissociation of molecules. As pH is a measure of the hydrogen ion concentration, a change in the temperature of a solution will be reflection by a subsequent change in pH (Baron *et al.*, 2010). These reasons account for observed behaviour.

Total soluble solids

Recorded mean soluble solid was 2 ± 0.79 °O. Non-significant effect of heating total soluble solid was recorded ($p > 0.05$). Figure 3 shows a slight reduction in total soluble solid with rise in temperature. Among the principal thermally reactive components during roasting are monosaccharides

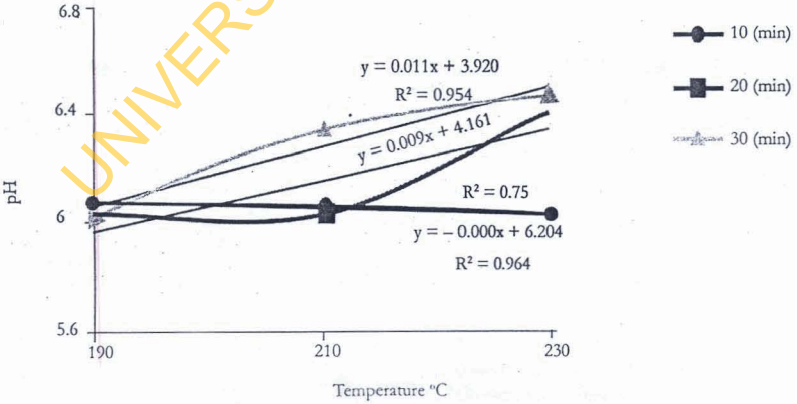

Fig. 2: Plot of roasting temperature against pH at different roasting duration

and sucrose. Hydrolysis of starch in carbohydrate to simple sugar was expected to remarkably influence total soluble solids. Low moisture content of this seed might have caused the obtained result.

Total titratable acidity

Total titratable acidity ranged from 0.33 to 0.47 mg/g. Mean value of 0.39 ± 0.04 mg/g was recorded. Decline in total titratable acidity as a result of rise in roasting temperature and time was noticed (Figure 4). This observation may be attributed to degradation of acids as a result of high temperature employed during roasting.

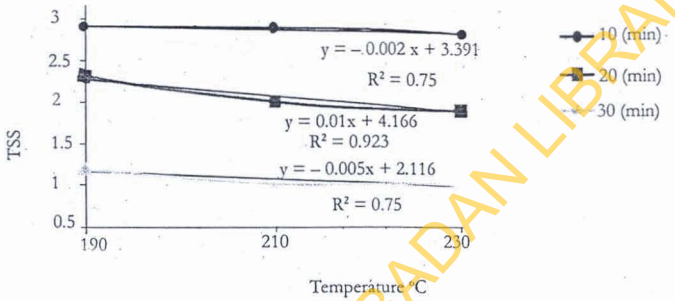

Fig. 3: Plot of roasting temperature against TSS at different roasting duration

Acetic acid

The acetic acid of treated samples ranged from 0 to 0.06%. Analysis of variance (ANOVA) of the data showed no significant difference ($p > 0.05$). Relationship between acetic acid of *Cassia sieberiana* and roasting duration and temperature is polynomial in nature (Figure 5).

Weight loss

From Figure 6, it is obvious that weight loss increased

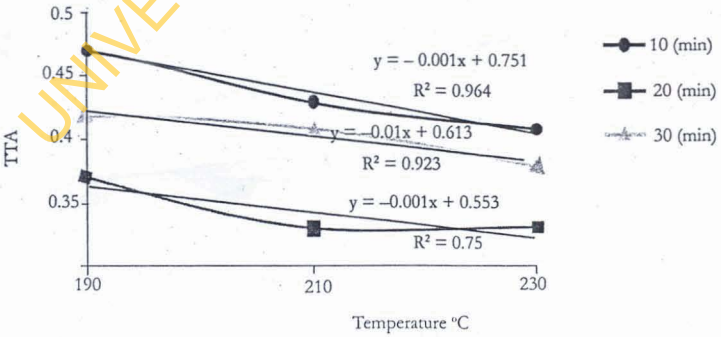

Fig. 4: Plot of roasting temperature against TTA at different roasting duration

with increased roasting duration and temperature. This may be due to loss of volatile material present in the seed, dehydration of moisture, pyrolysis and destruction of carbohydrates which are temperature dependent. Coffee bean roasted at 205°C experiences a weight loss of approximately 5% (CRI, 2006).

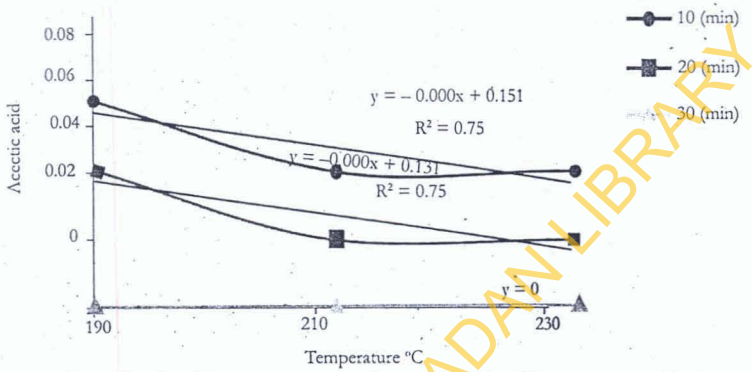

Fig. 5: Plot of roasting temperature against acetic acid at different roasting duration

Caffeine

Chemically, caffeine is a member of the xanthine family. Caffeine is odourless, has a bitter taste and is highly soluble in hot water (CRI, 2006). Caffeine occurs naturally in coffee, tea, cocoa, kola nut and a variety of other plants. The caffein content of the treated seed varied from 8.6 to 10.9%. Mean value was 10.04 ± 0.77 %. Effect of treatment was found to be significant ($p < 0.05$). On average, tea

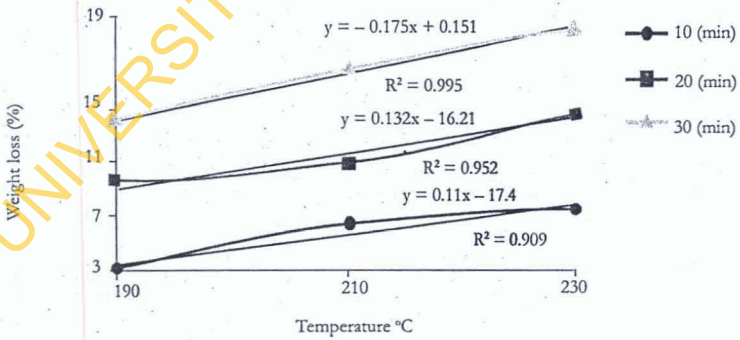

Fig. 6: Plot of roasting temperature against weight loss at different roasting duration

leaves contain 3% caffeine by weight. Many factors determine the caffeine content in the dry leaf, such as soil chemistry, altitude, type of tea plant, position of the leaf on the tea bush and cultivation practices (Anon, 2011). Graphical illustration of the effect shows that caffein content reduced with increase in roasting temperature and duration (Figure 7).

Swelling

From Figure 8, swelling increased with both roasting duration and temperature. CRI (2006) reported that coffee bean size was doubled when roasted at 205°C, which is similar to the observation in this study.

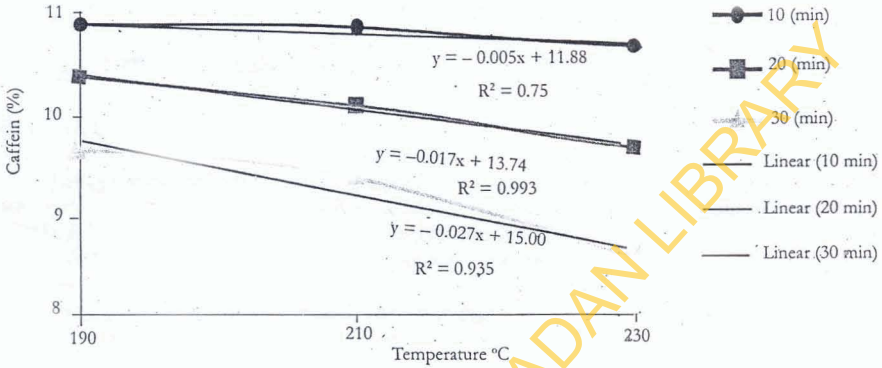

Fig. 7: Plot of roasting temperature against caffein at different roasting duration

Colour

Colour of the samples ranged from 0.62 to 0.95 abs. Effect of roasting was significant on colour. Caramelization and Maillard reactions are non-enzymatic browning promoted by heating (McGee, 2004). Polynomial model is fit to predict the relationship between roasted *Cassia sieberiana* colour

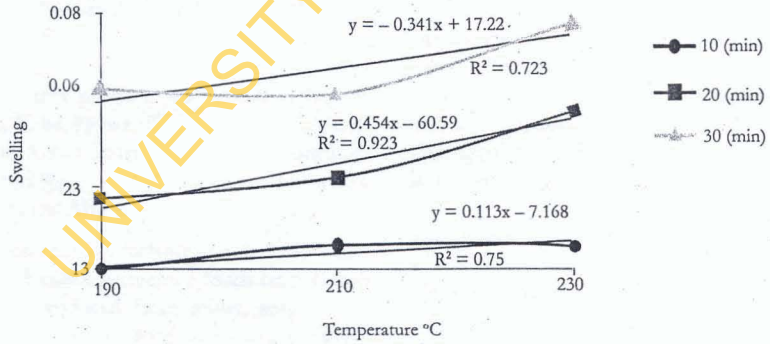

Fig. 8: Plot of roasting temperature against swelling at different roasting duration

and roasting temperature and duration (Figure 9). Coefficient of determination (R^2) of the model is high (1.0).

Conclusion

Cassia sieberiana has potential use as beverage. Roasting of the seed modified the physicochemical properties.

References

Afoakwa, E.O., Budu, A.S. and Merson, A.B. (2006). Application of response surface methodology for optimizing the pre-processing conditions of Bambara groundnut *(Voandzei subterranea)* during canning. *International Journal of Food Engineering* 2: 1 – 8.

Akinoso, R.. (2006). Effect of moisture content, roasting duration and temperature on yield and quality of palm kernel (*Elaeis Guineensis*) and sesame (*Sesamum indicum*) oils. PhD Thesis, University of Ibadan, Nigeria.

Amubode, F.O. and Fetuga, B.C. (1983). Proximate composition and chemical assay of methionine, lysine and tryptophan concentrations of some forest tree seeds. *Food Chemistry* 12 (1): 67 – 72.

Amubode, F.O. and Fetuga, B.C. (1984). Amino acid composition of seeds of some lesser know-tree. *Food Chemistry* 13 (4): 299 – 307.

Anon. (2011). www.fragrantleaf.com

AOAC, (2005). *Official Methods of Analysis* 18th ed. Association of Official Analytical Chemists, Gaithersburg, MD, USA.

ASABE (2008). Moisture measurement – Peanut. *American Society of Agricultural and Biological Engineers.* (ASAE S410.1 Dec. 1982 R 2008), 679 – 680.

Barbosa-Canovas, G.V., Juliano, P. and Peleg, M. (2006). Engineering properties of food in food engineering (In Gustavo, V. Barbosa-Canovas (ed.) *Encyclopedia of Life Support System* (EOLSS), Developed under the Auspices of UNESCO, Eolss Publishers, Oxford, UK. www.eolss.net

Baron, J.J., Ashton, C. and Geary, L. (2010). The effects of temperature on pH measurement. www.reagecon.com

CRI (2006). Coffee Research Institute. www.cri.org

Food and Agriculture Organization of the United Nations (2003). *FAO and the Information Network on Post-Harvest Operations* (INPhO). http://www.fao.org/docrep/T0207E/T0207

McClements, D.J. (2003) Analysis of carbohydrates. http://www-nix.oit.umass.edu/~mcclemen/. Accessed January 9, 2010.

McGee, H. (2004).. *On Food and Cooking.* Revised Edition. Scribner. ISBN 0-684-80001-2.

Moretimore, M.T. (2010), Famine Food. Compiled by – Robert Freedman. www.hort.purdue.edu/newcrop/.../fabaceae.html – United States.

Mumin, M.A., Akhter, K.F., Abedin, M.Z. and Hossain, M.Z. (2006). Determination and characterization of caffeine in tea, coffee and soft drinks by solid phase extraction and high performance liquid chromatography (SPE – HPLC). *Malaysian Journal of Chemistry* 8 (1): 45 – 51.

Olapade, A.A. and Akinoso, R. (2004). Design of a rotary roaster for Cassia sieberiana Seeds. In: The Role of Agricultural Engineering in Boosting Food and Agricultural Production in Developing Economy. Ogunlela *et al.* (eds.) *Proceedings of the Nigerian Institution of Agricultural Engineers* 26: 322 – 325.

Toma, I., Karumi, Y. and Geidam, M.O. (2009). Phytochemical screening and toxicity studies of the aqueous extract of the pods pulp of *Cassia sieberiana* DC. (*Cassia kotchiyanaoliv.*). *African Journal of Pure and Applied Chemistry*, 3 (2): 26 – 30.

Zumdahl S.S. (1993). *Chemistry* 3rd Edition. D.C. Health & Co, 356 pp.