IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 11, Issue 8 Ver. I (August. 2017), PP 28-36
www.iosrjournals.org

Evaluation of the ISO quality (ISOQ) of 77 imported tea clones (NGC 1-77) as suitable raw materials for the production of black and green tea in Nigeria

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Abstracts: *This experiment was designed to characterize the chemical components of 76 tea clonal materials .(NGC1-77).imported into Nigeria on their suitability as raw materials for the production of Green tea The 77 tea clonal materials imported from China were established on the Mambilla Highland (1450m above mean sea level) The tea were plucked in the manner of material for either for black tea (1+2) or green tea production (1+1) using the bud and the first two leaves and dried at 100^{O}C temperature before the chemical analysis. Quality parameters assessed include, % moisture content, %Tannin, %crude fibre, % total ash and caffeine .The quality of the raw materials were compared with the standard quality parameters as recommended by the international organization for standardization (ISOQ) for tea using protocols of ISO9763, ISO 1575, ISO5498, for moisture content, crude fibre and total ash. .The % MC of the tea clones differed significantly among the imported tea clones and between indigenous commercial clones and ranged between 5.67-7,17%, whereas the caffeine contents was within 1.67-2,39%,. The Tannin content of the tea were significantly different ($p<0.05$) and these fell within 1.25-4,77%. The % crude fibre (CF) and the total ash (TA) were within 13.3-15.41 and 5.02-6.58% for CF and TA respectively. It was observed that the chemical parameters were significantly different between Nigerian clones and the imported varieties. This might be due to locational differences or clonal variations as Nigerian clonal materials established earlier was imported from Kenya while the new materials were from China In conclusion, all the quality assessed fell within the recommended quality characteristics recommended by the National Industrial standards (NIS) and can serve as suitable raw material for black and tea production*

Originality/value: *This study is the first on quality of foreign tea clone planted in the Nigerian environment*

Key words*: Green tea, Highlands, Kenya, China, quality*

Date of Submission: 17-05-2017 Date of acceptance: 25-08-2017

I. Introduction

Many parameters are used as diagnostic indices for selective identification of good quality tea leaves as suitable raw materials for the production of Black or Green Tea. Parameters such as Moisture content, Crude fibre, Caffeine, Water extracts, Tannin, Catechin etc. are among some important ones used in the tea industry. Aroyeun 2013found out that clonal variations was responsible for variations in black and green tea chemical parameters evaluated which also suggested a very large generic variations (Magoma*etal,* 2000).. The quality of raw material for tea in Nigeria must conform to the Nigerian Industrial Standard recommendation. The recommended value that reflected in the National Industrial Standard emanated from the adopted value of the International Organization for Standardization i.e. ISO. For example an ISO 3720, 1986 recommends that any material that can be appropriate for Black or Green Tea should have crude fibre not exceeding16.5%. According to the international standard, water extracts of tea which is the soluble matter extracted from a test portion by boiling water, under the condition speculated by the international standard expressed by mass on a dry bases (ISO 9768, 1994)should fall within the range 21- 45% levels. Other authors have considered total polyphenol, tannin, amino acids, theaflavin, thearubigin as quality indices of tea.. The caffeine contents of tea is an alkaloid and increases alertness in consumers or tasters of tea. Efforts are currently on the increase to produce low caffeine teas or completely decaffeinated tea because of the health implications (Aroyeun*et al*., 2012). The caffeine levels was recently reported byAroyeun 2013) as an important quality parameter of tea. The production of Black tea in Nigeria dated back to 1972 when clonal materials were imported from Kenya into Nigeria. The materials imported were multiplied and established in Nigeria at the Mambilla Highland (1450 amsl). The clonal materials have now become commercial tea clones with desirable parameters for black and green tea (Aroyeun

2012; Odumbaku*et al.,* 2015). Because of this favourable result, an attempt was also made to import clonal materials from China (The Home of Tea) for establishment in Nigeria. The clonal seeds were propagated and stems were cut and planting materials were generated. The tea leaves produced high yield. The high yield of the tea leaves may not be considered as enough factors to encourage the continued propagation of these clonal seeds without understanding the relevant quality values of those clonal materials. Carrying out this study will assist our decision to select clones that have the potential quality values for the production of both Black and Green tea and to identify other quality parameters different from already established commercial tea clones. A great variety of tea trees and products can be found in the vast tea producing areas of China. Classification of tea has been fairly well established based on quality and processing methods. Fresh tea leaves contain many chemical compounds which determines the quality of the manufactured tea (TCTCP, 2008). Physical and chemical characteristics of fresh tea leaves differ with variety of tea plant. TCTCP, 2008. The tea leaves primary quality parameters affect the final product whether Black, Green, Oolong, White, Yellow or Dark tea. Other Researchers have reported the evaluation of anthocyanins, flavonoids as quality factors in material for Black or Green tea production. Black tea is produced through oxidative breakdown of tea catechins by the polyphenol oxidase enzymes into Theaflavins and Thearubigins which are both responsible for the colours and taste of black tea infusion. Green tea, on the other hand is an unfermented product with arrested enzyme activities of the polyphenol oxidase enzyme. Other factors such as region of production have also been reported as factors that affect chemical quality characteristics of clonal black tea Part of the difficulty in making a valid comparison in the quality of tea from different parts of the world is the ability to source plants of the same generic make-up grown in different environments (Owuor*et al* 2008). In 2008, the exchange of clonal materials between China and Nigeria has necessitated the development and establishment of 77 tea clonal varieties for test under different environments, All the tea seeds have demonstrated good desirable attributes in the areas they were produced. The character of all the 77 clones isshown in Table 1. The aim of this work is to racterize the chemical quality parameters of these materials for their suitability in the production of Black and Green tea in Nigeria.

II. Materials and Methods

The tea leaves used in this study were obtained from vegetatively propagated (VP) cultivar tea field at the Cocoa Research Institute of Nigeria, tea plantation station located at latitude 20^0E, long 42^0W and 1450m amsl. The plants were grown under recommended agronomic practices. The cultivars were plucked and dried immediately before transportation to the laboratory for tea leaves analysis without the necessary protocols of Black tea production i.e. fresh leaves – withering – fermentation – rolling and drying or the green tea processing protocol. Viz: leaves – withering – fixing – rolling – drying.

Chemicals/Reagents
Caffeine
Lead Acetate solution $(CH3COO)_2Pb$.
100g was dissolved and diluted to 200 mLwith distilled water.
Hydrochloric acid solution, HCl.
36%, specific gravity, 1.18, 0.9 mL was dilutedto 100 mL with distilled water.
Sulphuric acid solution
Sulphuric acid (98%) H_2SO_4, specific gravity,
1.84, 16.7 mL) was diluted to 100 mL with distilled water.

Measurements:

Tea solution (10 mL), HCl (5mL) and Lead acetate solution (1 mL) were mixed in a 100 mL volumetric flask and diluted with distilled water. The solution was then filtered through Whatman No. 1 quantitative filter paper. The filtrate (25 mL) and sulphuric acid solution (0.3 mL) were placed in a volumetric flask and diluted to 50 mL with distilled water. The solution was filtered using the same type of filter paper. The absorbance of the filtrate was measured using Ultraspec III UV /visible spectrophotometer at 274 nm. The measurement was performed in triplicates.

Standard curve
Caffeine stock solution (10 mL), 1 mg/mL, w/v in distilled water was diluted to 200 mL with distilled water. Next, 0, 10, 20, 30, 40, or 50 mL of the diluted caffeine solution were separately mixed, each with Hydrochloric acid solution (4 mL) in a volumetric flask are diluted to 100 mL with distilled water. Thereafter, the remaining steps were repeated asdescribed earlier. The readings of the standard solution against the concentrations were used to prepare the standard curve.

Calculation

Caffeine (%)= E/1,000 xV_0x (100/V_1) x (50/25)/W = 0.2EV_0/V_1/W

Where E is 'mg' of caffeine from the standardcurve against the reading of the spectrophotometerand E/1,000 is to convert 'mg' into 'g'. $V_0$is the total volume of the tea solution (250 mL); V_1 is the volume used for the measurements (10 mL), and 100/V_1 indicates 10 mL tea solutionsthat were diluted to 100 mL, while 50/25shows that another dilution from 25 mL tea filtratemade to 50 mL in the measurement. W isthe dry weight of the tea sample.

Total ash was evaluated using ISO 1575

Statistical analysis

One way Analysis of Variance (ANOVA) was performed to show the general trend of the experimental data. SPSS version 10.0 (SPSS Inc. Chicago, IL, USA) statistical Package was used.

Table 1: Leaf characteristics of NGC 1-77tea clones

	LEAF COLOUR	LEAF TEXTURE	LEAF EDGES	Veination		LEAF COLOUR	LEAF TEXTURE	LEAF EDGES	Veination
NGC 1	Deep Green	Rough	Serrated	Net	NGC 40	light Green	Rough	Serrated	Cluster
NGC 2	Green	Rough	Serrated	Net	NGC 41	Green	Rough	Serrated	Net
NGC 3	Green	Rough	Serrated	Net	NGC 42	Green	Rough	Serrated	Net
NGC 4	Deep Green	Rough	Serrated	Cluster	NGC 43	light Green	smooth	Serrated	Net
NGC 5	Deep Green	Rough	Serrated	Cluster	NGC 44	0	0	0	
NGC 6	Green	Rough	Serrated	Cluster	NGC 45	Green	Rough	Serrated	Net
NGC 7	Green	Rough	Serrated	Cluster	NGC 46	Green	Rough	Serrated	Net
NGC 8	Green	Rough	Serrated	Cluster	NGC 47	light Green	Rough	Serrated	Net
NGC 9	Deep Green	Rough	Serrated	Cluster	NGC 48	Deep Green	Rough	Serrated	Net
NGC 10	Green	Rough	Serrated	Cluster	NG 49	light Green	Rough	Serrated	Net
NGC 11	Green	Rough	Serrated	Net	NGC 50	Deep Green	Rough	Serrated	Net
NGC 12	Deep Green	Rough	Serrated	Cluster	NGC 51	Deep Green	Rough	Serrated	Cluster
NGC 13	Green	Rough	Serrated	Cluster	NGC 52	light Green	Rough	Serrated	Cluster
NGC 14	Green	Rough	Serrated	Net	NGC 53	Green	Rough	Serrated	Net
NGC 15	Green	Rough	Serrated	Cluster	NGC 54	Green	Rough	Serrated	Net
NGC 16	Deep Green	Rough	Serrated	Net	NGC 55	yellowish Green	smooth	Serrated	Net
NGC 17	light Green	Rough	Serrated	Cluster	NGC 56	Deep Green	Rough	Serrated	Cluster
NGC 18	Deep Green	Rough	Serrated	Cluster	NGC 57	Green	Rough	Serrated	Cluster
NGC 19	Deep Green	Rough	Serrated	Cluster	NGC 58	light Green	Rough	Serrated	Net
NGC 20	Deep Green	Rough	Serrated	Net	NGC 59	Green	Rough	Serrated	Net
NGC 21	Green	Rough	Serrated	Cluster	NGC 60	Deep Green	Rough	Serrated	Net
NGC 22	light Green	Rough	Serrated	Net	NGC 61	Deep Green	Rough	Serrated	Cluster
NGC 23	light Green	Rough	Serrated	Cluster	NGC 62	light Green	Rough	Serrated	Cluster
NGC 24	Deep Green	Rough	Serrated	Cluster	NGC 63	light Green	Rough	Serrated	Cluster
NGC 25	Green	Rough	Serrated	Cluster	NGC 64	light Green	Rough	Serrated	Cluster
NGC 26	Green	Rough	Serrated	Net	NGC 65	light Green	Rough	Serrated	Net
NGC 27	Deep Green	Rough	Serrated	Cluster	NGC 66	light Green	Rough	Serrated	Net
NGC 28	Deep Green	Rough	Serrated	Cluster	NGC 67	light Green	Rough	Serrated	Net
NGC 29	Deep Green	Rough	Serrated	Net	NGC 68	light Green	Rough	Serrated	Net
NGC 30	Green	Rough	Serrated	Cluster	NGC 69	Deep Green	Rough	Serrated	Net
NGC 31	light Green	Rough	Serrated	Net	NGC 70	Deep Green	Rough	Serrated	Net
NGC 32	Green	Rough	Serrated	Net	NGC 71	Green	Rough	Serrated	Net
NGC 33	Green	Rough	Serrated	Cluster	NGC 72	Green	Rough	Serrated	Cluster
NGC 34	light Green	Rough	Serrated	Cluster	NGC 73	Deep Green	Rough	Serrated	Net
NGC 35	Green	Rough	Serrated	Cluster	NGC 74	Green	Rough	Serrated	Net
NGC 36	Deep Green	Rough	Serrated	Cluster	NGC 75	Deep Green	Rough	Serrated	Net
NGC 37	Green	Rough	Serrated	Net	NGC 76	yellowish Green	smooth	Serrated	Net
NGC 38	Green	Rough	Serrated	Net	NGC 77	Deep Green	Rough	Serrated	Net
NGC 39	Green	Rough	Serrated	Net					

III. Result and Discussion

Tannins: Tea tannin has been used to describe a mixture of more than twenty phenolic substances in tea, which are now known to consist of four main classes: Flavanols (formerly known as catechin), flavanol glycosides, leucoanthocyanins and depsides. Our findings showed that there were significant differences ($p<0.05$) in the tannins of the tea samples analysed. In table 1, it was observed that there were differences in the leaf characters which obviously may affect the chemical components. Since the clones were planted under the same agronomicconditions it may be difficult to infer that agronomic factors might have played a role or probably contributed to the differences in the Tannins recorded in our study. Variations in the genetic make up of the individual clones might have played a significant role.Odunmaku*et al*, 2015 reported variation in tea samples optimized for green tea production inflavanol, an example of thefour main classes of Tannins. Although catechin groups like Epicatechins, gallocatechins and their gallated compounds like Epicatechingallates, Epigallocatechingallates were influenced by steaming temperature, duration and drying temperature, it will be necessary to modify the processing procedures in order to control the factors that will aggravate the production of too high Tannin in the tea and optimize the condition that willreduce the Tannin concentration in the processed tea leaves since too much Tannin may lead to an increase in astringency which may adversely affect the tea quality

Caffeine: A definitive study of the caffeine contents of a variety of teas, including Black,Green and Stalky teas have been reported (Aroyeun*et al*,2012). The caffeine content in 77teaClones obtained in this study (foreign clones) showed significant differences in qualitiesperhaps due to differences in a range of climatic and topographical conditions andManagementfactors in the country of origin (China) and Nigeria when compared tocommercial clones already available within the tea gene pool on the Mambilla highland,Nigeria.The range of values obtained by Siripat et al., 2009 was between 3-4% for infusionsbrewed from rolled Butsoongnerm 2006 and Butsoognerm*et al*., 2005 observed that thedissolution rate of caffeine from the rolled leaves was lower than that from loose leaves.Comparing caffeine result in our studies and other previous studies there seemedtobe no significantdifferences in reported values for % caffeine in tea. Aroyeun 2012observed a range of valuesbetween 1.29-2.56%. for caffeine in commercial tea clones 228,318, 68,35, 363 and 236 processed into green tea. These values were supported by the reportsof Imran *et al*., 2014 who reported range of caffeine values between 1.22-1.25% in tea brandsavailable in the market of Pakistan. Our study showed range of values of caffeine between1.62% -3.52%different from the caffeine contents of commercial tea clones analysed byAroyeun*et al*., 2012. Thelowest caffeine obtained in our studies fell within the levelsreported in the literature Siripat*et al*, 2009. All the tea clones analysed were within theavailable caffeinecontent of black or green tea. The least caffeine was obtained in NGC 35 while the highest caffeine of 3.52% was found in NGC 61. About 57% of the tea analysedfell within 2.0 -2.99% for caffeine(fig. 2).

Crude Fibre: Crude fibre is made up of cellulose and lignin, hard substances that form the framework of the leaf. Being insoluble in water, they do not form a part of the tea infusion. They are unimportant when we consider tea as a beverage. Crude fibre has some significance; however, since a poor tea containing a high percentage of stalk will have high crude fibre content. Quality is thus inversely proportional to crude fibre content. (Aroyeun 2013, ,Aroyeun, *et al* 2012) reported different values for crude fibre of Black and Green tea respectively. According to table 2, the least value for crude fibre was 11.54% inNGC 74 while the highest value was found in NGC 40. The resultsobtained in this study was in consonance with these previous reports.

Table 2: Chemical components of 77 tea clones

NGC	Moisture	Caffeine	Tannin	Crude Fibre	Total Ash	NGC	Moisture	Caffeine	Tannin	Crude Fibre	Total Ash
1	6.21	2.04	3.26	13.44	5.86	40	6.71	2.44	1.59	17.81	6.34
2	6.86	1.91	2.38	13.87	6.09	41	6.26	2.61	4.28	14.06	5.95
3	6.15	2.21	4.11	14.06	5.27	42	6.74	2.53	4.79	15.15	5.67
4	6.47	2.36	2.87	13.32	5.31	43	6.82	2.41	3.29	14.67	5.71
5	5.82	2.25	3.15	13.25	6.15	44	0.00	0.00	0.00	0.00	0.00
6	6.75	2.28	3.08	13.41	5.44	45	6.91	2.39	4.55	13.66	5.69
7	6.88	1.78	4.31	13.67	5.33	46	6.18	2.57	3.31	13.38	6.34
8	6.79	2.07	4.77	14.38	6.23	47	5.38	3.24	3.57	15.27	6.42
9	6.95	1.96	4.69	14.21	5.92	48	6.59	2.55	3.69	14.05	6.39
10	6.52	2.37	1.69	14.15	6.11	49	6.63	2.49	1.94	13.82	5.81
11	7.08	1.75	1.57	13.96	5.95	50	6.72	2.32	1.75	13.75	5.94
12	6.91	1.84	1.25	13.73	5..06	51	5.69	3.31	1.61	13.34	6.11
13	7.13	1.92	1.75	13.65	5.09	52	5.47	3.35	1.06	14.63	6.26
14	6.82	2.16	1.61	14.21	5.21	53	6.02	2.96	1.29	14.56	6.44
15	7.05	2.12	1.64	14.35	5.44	54	6.15	2.84	1.71	13.62	6.15
16	6.79	1.87	1.46	13.65	6.07	55	6.18	2.75	4.06	13.35	5.84
17	6.44	1.81	1.83	14.15	6.11	56	6.25	2.66	3.91	14.97	6.08
18	6.37	2.05	4.17	14.29	6.24	57	6.73	2.43	5.08	13.14	6.13
19	6.56	2.21	3.54	15.26	6.32	58	6.05	2.87	5.25	14.27	6.21
20	6.49	2.33	3.61	14.89	6.17	59	5.25	3.29	4.26	14.33	6.06
21	6.28	2.31	2.62	15.37	5.94	60	5.47	3.44	4.52	13.71	6.18
22	6.35	2.18	2.94	15.41	6.13	61	5.21	3.52	3.74	13.63	6.24
23	6.27	1.98	2.39	14.77	5.86	62	6.35	2.98	4.33	13.51	6.15
24	6.31	2.23	3.14	13.81	5.32	63	6.09	2.88	4.54	14.29	5.94
25	6.24	2.35	2.78	14.05	5.02	64	6.17	2.69	5.06	14.38	5.86
26	5.67	2.39	2.37	14.29	5.31	65	6.38	3.25	5.11	13.72	5.25
27	6.15	2.14	3.14	13.71	5.65	66	5.85	3.06	5.23	13.55	5.09
28	6.44	1.72	2.88	13.58	6.58	67	6.75	2.29	4.29	14.27	5.31
29	6.71	1.85	2.69	15.06	5.91	68	6.96	1.88	4.36	13.66	5.29
30	6.69	1.90	3.08	14.66	5.74	69	6.98	1.79	4.87	14.09	6.03
31	6.96	1.67	2.74	14.51	6.32	70	7.03	1.66	6.34	15.11	5.65
32	7.02	1.73	2.91	14.32	5.23	71	7.32	1.59	4.88	12.99	4.83
33	7.17	1.77	3.22	14.26	5.37	72	6.52	2.11	4.73	13.73	5.42
34	5.21	3.41	1.37	17.27	5.67	73	6.84	2.05	5.11	12.07	5.37
35	6.88	1.62	1.38	16.47	5.87	74	5.81	2.37	4.61	11.54	4.96
36	7.21	1.75	1.53	16.68	6.13	75	5.66	2.14	3.48	12.35	5.17
37	7.18	1.86	1.48	17.33	6.26	76	6.08	1.89	3.97	12.19	4.89
38	7.05	2.27	1.66	17.47	6.39	77	5.77	2.05	4.02	11.85	5.11
39	6.97	2.09	1.49	17.19	6.21						

Moisture content

Moisture content is an important quality parameter of tea (Robert and Smith, 1963) and is usually neglected by Researchers but not by the Industries or the traders. Tea Researchers (Othienoand Owuor, 1984, Robinson and Owuor, 1993) suggested that the M.C. of the teas should be controlled to lie below 6.5% for marketing teas, whereas Millin, 1987 noted teas had a M.C. of 8.5-9.5% during retailing. The moisture contents of majority of the samples fell within 6.51-7.5%. Although there were no significant differences between these samples and the recommended value of 6.8%, the values above 6.6% must have been due to the high humidity of the processing location . Generally the drying of the tea leaves was adequate and the moisture level did not pose any threat due to microbial contamination. The distribution of Moisture contents and the tea clones that fell under different levels were shown in figure 1.while Table 2 showed the clones categories and the variations in the moisture levels.

Total Ash

The total Ash according to ISO 1575 is 8% maximum and 4%minimum. Our studies established that allthe tea clones analysed fell within the range of 4-8% without too much deviation from the recommendation by ISO for total ash of tea samples. This results was in conformity with previous reports of Aroyeun*et al*., 2012 which indicated that five tea samples from Mambilla highlands were higher than 8%. The samples were confirmed to vary in total ash based on grades differences. For example it was established by Aroyeun*et al*., 2012 that Fibre grade tea samples was highest in total ash than the broken pekoe, dust or pekoe fannings respectively.

IV. Conclusion

This study established the good qualities of imported tea clones from China (NGC1-77) as suitable materials that can be further used in the production of black or green tea in Nigeria. It will be laudable therefore if further work can be done to establish the Catechincontents ,Theaflavin content and thearubigin contents of these tea including their significant organoleptic properties

Acknowledgement

The author appreciated the Executive Director, CRIN, for permission to publish this paper

Table 3: Classification of Tea Clones nased on Chemical Quality Parameters

ISO values	Quality parameters	Tea samples
Maximum	**Moisture Content**	1,2,3,4,5,17,18,20,21,22,24,25,26,
	<6.5%	27,28,34,41,46,47,51,52,53,54,55,56,58,59,60,61,62,63,66,74,75,76,77
		6,7,8,9,10,11,12,13,14,15,16,19,23,29,30,31,32,33,35,36,37,38,39,
	>6.5%	40,42,43,45,48,49,50,57,67,68,69,70,71,72,73
Range		2,7,9,11,12,13,16,17,23,28,29,30,31,32,33,35,36,37,
1.0-4.0%	**Caffeine**	68,69,70,71,76
	1.0-1.99	1,3,4,5,,6,8,10,14,15,18,19,20,21,22,,24,25,26,27,38,39,40,41,42,43,45,46,48,49
		,50,53,54,55,56,57,56,62,
	2.0-2.99	63,64,67,72,73,74,75,77
		34,47,51,52,59,60,61,65,66
	3.0-3.99	
		12,16,34,35,37,39,52,53
	Tannin	2,4,10,11,13,14,15,17,21,22,23,25,26,28,29,31,32,36,38,40,49,50,51,54
	0 – 1.5	1,5,6,19,20,24,27,30,33,43,46,47,48,56,61,75,76
	1.51-3.0	3,7,8,9,18,41,42,45,55,59,60,62,63,67,68,69,71,72,74
		77,
	3.1-4.0	57,58,64,65,66,70,73
	4.1-5.0	
	5.1-6.5	73,74,75,76,77
		5,46,51,55,57,71
Maximum	**Crude Fibre**	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,24,25,26,27,28,32,33,41,45,46,48,49,4
16.5%	11-12.4	0,54,58,59,60,61,62,63,64,65,66,67,68,69,72\
	12.41-13.4	19,20,21,22,23,29,30,31,42,43,47,52,53,56,70
	13.41-14.4	nd
		34,35,36,37,38,39,40
	14.41-15.4	
	15.41-16.4	25,71,74,76
	16.51-18.0	1,3,4,6,7,9,11,12,13,14,15,21,23,24,26,27,29,30,32,
		33,34,35,41,42,43,45,49,50,55,63,64,65,66,67,68,69,70,72,73,75,77
	Total Ash	2,5,8,10,16,17,18,19,20,22,28,31,36,37,38,39,40,46,
Maximum-8%	4.0-5.0	47,48,51,52,53,54,56,57,58,,59,60,61,62
Minimum -4%	5.1-6.0	
	6.1-7.0	

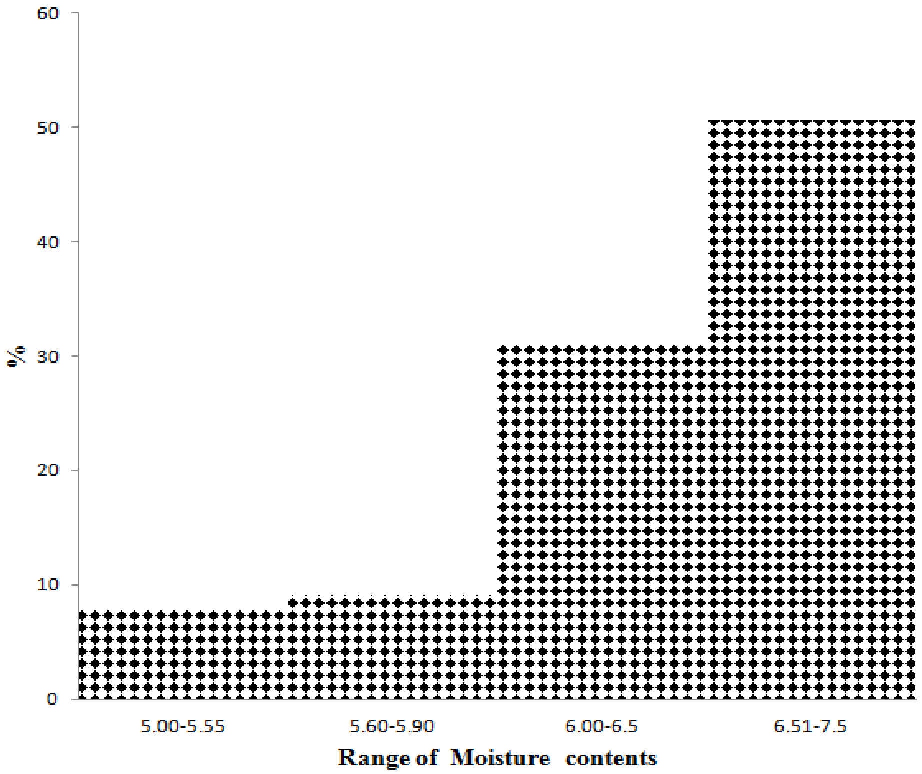

Fig 1: The range of Moisture contents of tea samples

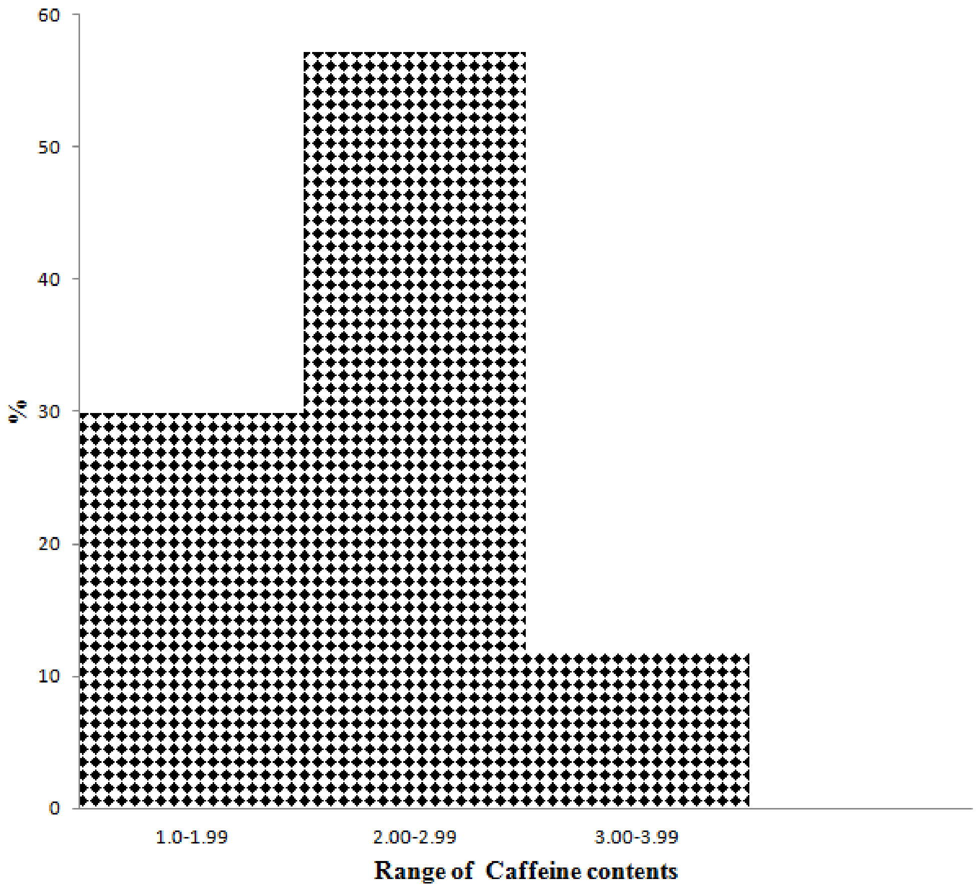

Fig 2: The range of Caffeine contents and their percentage frequency

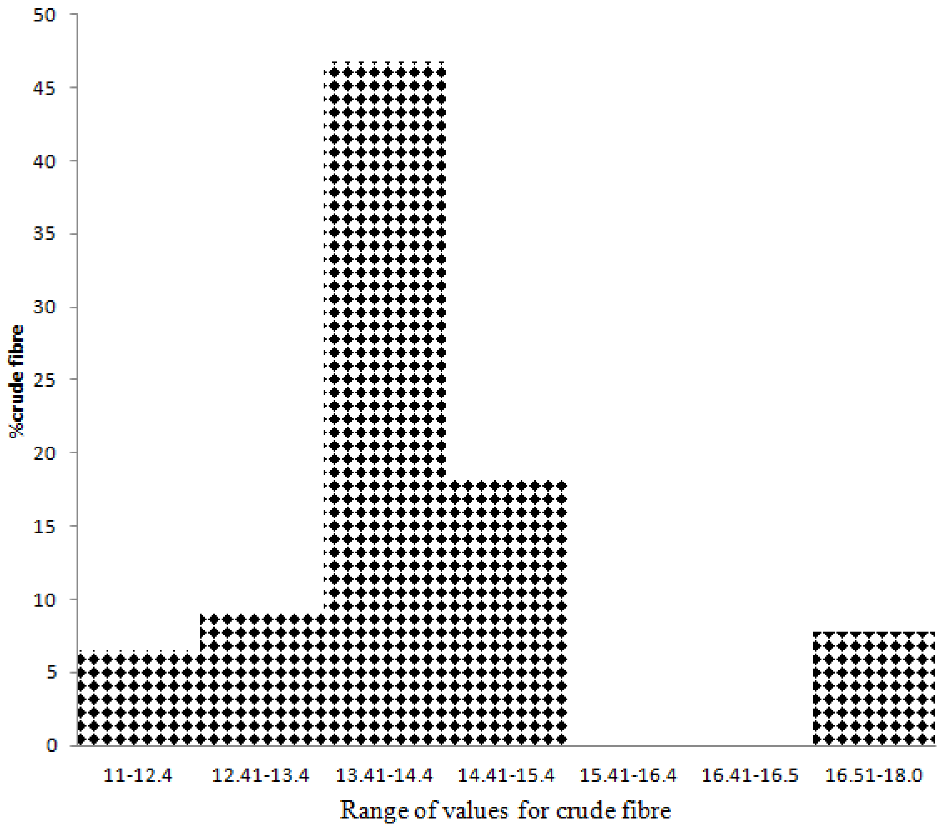

Figure 3: Percentage Distributions of Crude Fibre of the Tea Cones

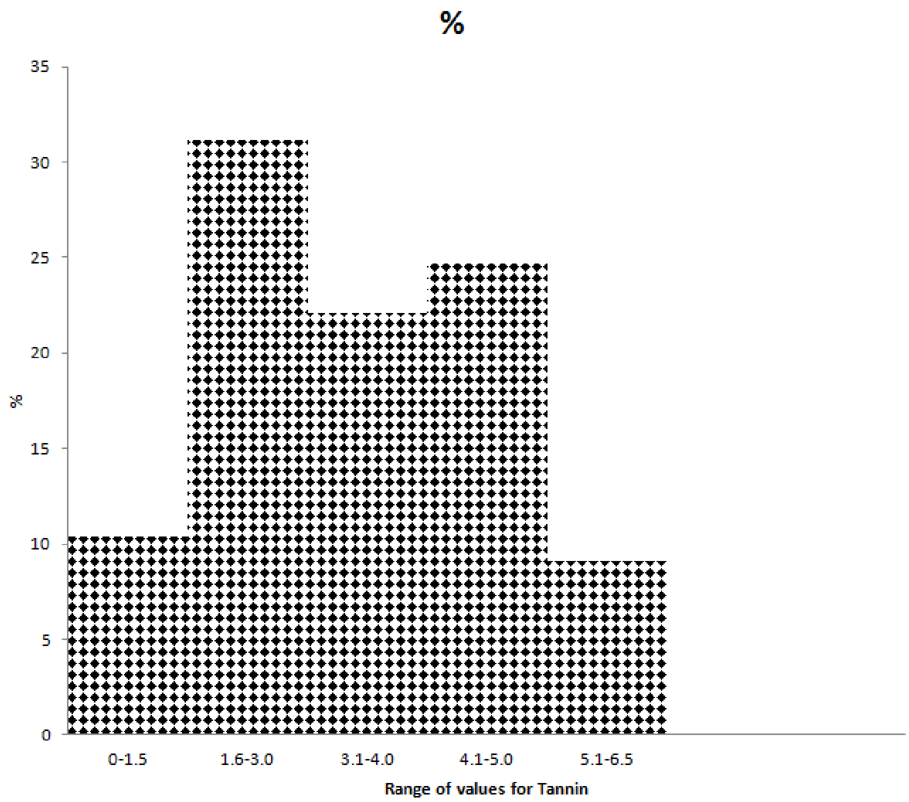

Figure 4: Percentage Distributions of Tannins of Tea Clones

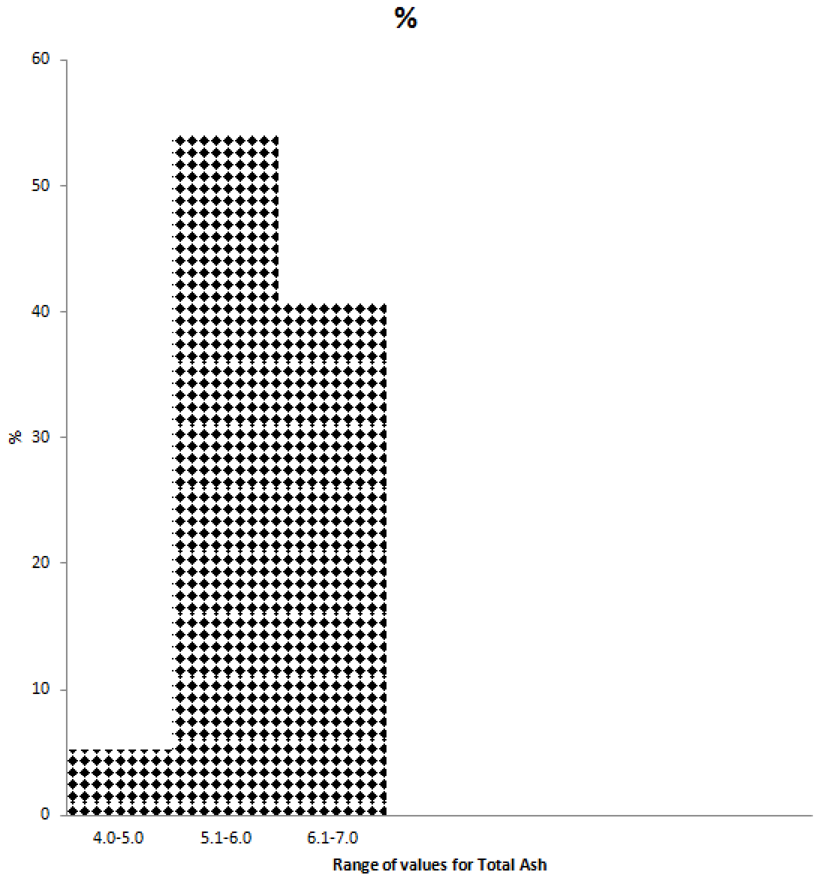

Figure 5: :The Total Ash contents of 77 tea clones imported into Nigeria

References

[1] Aroyeun 2013 crude fibre, water extracts, total ash, caffeine and moisture contentsas diagnostic factors in evaluating green tea quality. Italian Journal of Food Science vol 25, pages 70-75

[2] Aroyeun S.O., G.O.Iremiren, Omolaj, S.S., Okelana, F.A., Olubamiwa O., R.R Ipinmoroti, Oloyede A., Ogunwolu, S.O., Daniel, M.A., Jayeola C.O., SowunmiFatai A., and Odumbaku, L.A (2012) Developing local Processing Technology for Black and Green Tea and evaluation of Conformance to ISO standard. *World Journal of Science, Technology and Sustainable Development vol 9 (4) pp 317-325*

[3] Magoma G., Wechins F.N., Obanda M., Imbuga M. and Agong S.G. 2000. The use of catechins as biochemical markers in diversity studies of tea (*Camellia sinensis*). Genetic Bioresource and Crop Evol. 41: 107-114.

[4] Roberts E.A.H. and Smith R.F. 1963. The phenolic substances of manufactured tea IX. The spectrophotometric evaluations of tea liquors. J. Sci. Food Agric.14: 689-700.

[5] Robinson J.M. and Owuor T.O. 1992. Tea aroma. In: Teacultivation to consumption. K.C.

[6] Wilson and M.N. CliffordEds., London, Chapman and Hill, Chapter 18, pp.603-647.

[7] Millin D.J. 1987. Factors affecting the quality of Tea. In:Quality control in the food

[8] Industry. S.M. HeracdocrierEd., London Academic Press, pp. 127-160.

[9] Othieno C.O. and Owuor P.O. 1984. Black tea quality andinternational standards. Int. Tea J.7: 27-30.

[10] Odunmbaku LA, Babajide JM, Shittu TA, Aroyeun SO and Eromosele CO(2015) Effect of Process Variables on the Chemical Constituents and Sensory.Characteristics of Nigerian Green Tea. Journal of Food Process Technol 2015, 6:11

[11] ISO 1839. 1980. Method of sampling tea. InternationalStandard Organization.

[12] ISO 3720. 1986. Black Tea- definition and basic requirements.International Standard Organization.

[13] ISO 9768. 1994. Tea-determination of water extracts. InternationalStandard OrganizationTCTCP, 2008. Training course on Tea Cultivation and Processing Technology for Developing Country, Changsha, Human Province , People Republic of China

Aroyeun S,O . "Evaluation of the ISO quality (ISOQ) of 77 imported tea clones (NGC 1-77) as suitable raw materials for the production of black and green tea in Nigeria." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) , vol. 11, no. 8, 2017, pp. 28–36.