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DEVELOPING LOCAL PROCESSING TECHNOLOGY FOR BLACK AND GREEN TEA AND EVALUATION OF CONFORMANCE TO ISO STANDARD

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Abstract

Purpose – This project was designed with the aim of developing a black and green tea processing technology for Nigerian farmers and evaluating the conformance of the quality of the processed tea to the recommended international standard.

Design/methodology/approach – Locally processed and graded black teas were collected from Kakara and Bangoba for analysis. The different grades analyzed were Dust 1, Pekoe fanning (PF), Broken pekoe (BP) and Fibre. Green tea was also processed from twenty-one tea clones selected from the Cocoa Research Institute, Kusuku station's tea plantation located at 1840m above mean sea level and analyzed for quality characteristics. The methods used for the quality of black and green tea analysis were in accordance with the ISO standard. The ISO 9768 method (revised) was used for determining percentage water extract, 5498 for crude fibre, ISO 1575 for percentage total ash, ISO 1577 for acid-insoluble ash. Other additional quality parameters evaluated for black tea were theaflavins (TF), thearubigins (TR) and colour brightness (CBr)

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from another set of seventeen clones using Flavonost methods. Conformance to the ISO standard was assessed in all tea locally processed by the farmers in comparison to those processed under controlled conditions.

Results/findings – The results obtained in this study revealed that 59.2 per cent of the tea analyzed conformed to ISO 9768, 81.5 per cent to ISO 5498, 77.8 per cent to ISO 1575, 96.3 per cent to ISO 1576, 100 per cent conformed to ISO 1577 and 85.2 per cent to ISO 1578 respectively. In all, only 33 per cent of the processed tea conformed to international standards for black or green tea physical parameters. For black tea, the clones that conformed to the correct TF, TR andCBr were UNK, 367, 19, 74, 354, 368, 369, 353, 357, 143, 14 and 108 respectively.

Originality/value – The use of locally sourced clonal materials that conform to ISO standards from Nigeria could create new products (black and green tea) of high economic value to the farmers.

Practical implications –Production of green tea and black tea can take place locally without loss of quality if good manufacturing and hygiene practices are followed.

Keywords: *ISO, Tea quality, TF, TR, CBr, Conformance*

Paper type Research paper

INTRODUCTION

Tea beverages (from *Cammeliasinensis*(L.)O. Kuntze) are claimed to be the most widely consumed drinks after water (Owuor*et al.*, 2008). Due to the large demand, commercial production of the plant has been reported from as far as 49^{O} Ninthe outer Carpathians in the former Soviet Union to as far as 33^{O} Sin Natal, South Africa (Shoubo, 1989). The plant has adapted to environments with large climatic variations. These variations in environment and growing conditions are thought to cause variations in tea quality. The production of tea in Nigeria is carried out by the Nigerian Beverage Production Company (NBPC), which is located on the MambillaHighland (1430m above sea level) and the fresh tea leaves are supplied by an average of 2700 farmers, whose membership cuts across all the communities on the Highland. Recently, the NBPC, which is the only teaprocessing company in Nigeria, could not utilize all the fresh leaves supplied by farmers due to the low production capacity of their Lawrie Tea Processor (LTP). Thesefarmers' tea leaves were wasted

and their dependents began to suffer due to loss of income. This led to a mass movement from tea farming to arable farming as farmers began to experience poor eating habits, lack of healthcare andreduced training fortheir children. The standard of living dropped drastically. In order to reduce the poverty caused by this problem, this project was designed to study the effect of local tea processing on quality standardsin black and green tea locally produced in Nigeria. Farmers can then be educatedin the correct ways to process their tea locally without necessarily jeopardizing quality.

MATERIALS AND METHODS

Fresh tea leaves were obtained from Mambilla Highland, Nigeria. The tea plantation was located at 1430m–1840m above mean sea level. The plantation belonged to the Cocoa Research Institute of Nigeria, Ibadan, Kusuku, Mambilla. The tea (green and black tea) was processed locally. The black tea was produced using the orthodox method,andthe green tea was processed using Chinese methods viz: plucking (1+1), withering, fixing (pan firing), rolling and drying using a conventional oven. Twenty-one clonal materials were processed into green tea and 13 clones were processed into black tea using the orthodox method.The morphological parameters of all the clonal tea materials are presented in Table 1.The 21 fresh tea leaves were processed into green tea leaves comprising 14 clonal materials obtained from tea germplasm plots, which include: clone 228, 318, 68, 35, 61, 363, UNK, 367, 143, 357, 19, 25, 74, and 354. The tea clones used in black tea processing were: UNK, 367, 19, 74, 354, 368, 369, 353, 357, 143, 14, 238 and 108.Clone 318 was also divided into two, 318 LL1/2 was a lowland variety for black tea processing (1+2) and (1+1) of the same clone for green tea production. Another clone, 236, was also divided into two. 236 (sole) and 236 were intercropped with eucalyptus. Clone 318 was processed using Japanese methods (plucking, withering, steaming and drying). Clone 228 was processed using Chinese methods (plucking, withering, fixing, rolling and drying).Other teas analyzed were China tea grown in Nigeria, and natural hybrid tea (NHT). Some other tea samples were collected after processing and grading from farmers in Kakara and Bangoba, which are different green tea producing communities on the Mambilla Highland, Nigeria. The teas collected were of different grades, namely: Dust 1, Pekoe fanning (PF), Broken pekoe (BP) and Fibre (F), all from Kakara. Only BP was collected from Bangoba. In total,twenty-one samples were used.

QUALITY ASSESSMENT

The methods used for assessing the quality of black and green tea analysis were in accordance with ISO standards as shown in Table 2.ISO 5498 for crude fibre, ISO 1575 for percentage total ash, ISO 1577 for acid-insoluble ash.The quality parameters analyzed for black tea, were theaflavins (TF), thearubigins (TR) and colour brightness (CBR) using Roberts and Smith (1963) methods.Conformance to ISO standards were measured in all the samples.

S/N	Tea clones	Shape of leaf	Leaf serration	Leaf Area (cm^2)	Leaf colour	Internodes	Nature of flowering/seed production
1	1 & 2	Small and inward curving leaves	Closed serrated	2 x 1	Dark green	1.2cm	Has many flowers and seeds
2	367	Curved leaves	Wider serration	10 x 5	Light green	3cm	Rarely with flowers
3	19	Long, curved leaves	Normal	13 x 5	Light green	6cm	No flowers/seeds
4	74	Long, wide opened leaves	Wider serration	16 x 7	Light green	3cm	Rarely with their seeds
5	354	Small orange-like curved leaves	Closed	3.3 x 1.2	Dark green	8.5cm	No flowers/seeds
6	368	Long leaves	Wider serration	4.5 x 6.5	Light green	7cm	No flowers/seeds
7	369	Zigzag edges of leaves	Closed	12 x 5	Light green	6.5cm	No flowers/seeds
8	353	Slightly curved leaves	Wider serration	11 x 4.5	Light green	6cm	No flowers/seeds
9	357	Flat roundish leaves	Wider serration	10 x 5.5	Green	8cm	Less flowers/ seeds
10	143	Roundish flat leaves	Normal	10 x 4.5	Green	5cm	With flowers/ seeds
11	14	Curved long leaves	Normal	12 x 4.5	Green	5.5cm	No flowers
12	238	Curved leaves	Closed serration	13 x 5	Green	6cm	No flowers
13	25	Long curved leaves	Normal	6.5-7CM	Light green	6.5cm	No flowers
14	108	Wide leaves with bending edges	Wider serration	15.5 x 6.5	Light green	7cm	No flowers
15	363	Curved medium sized leaves	Closed serration	12 x 5	Light green	6cm	No flowers
16	35	Wide leaves	Normal	13 x 6	Light green to yellow	3cm	Rarely with flowers
17	68	Long curved leaves	Closed	11.5 x 4	Light green	6cm	With flowers
18	61	Orange-like leaves	Closed	11 x 4	Dark green	5cm	Pronounced flowers/seeds
19	228	Small orange-like leaves	Closed	6 x 3 cm	Light green to yellow	5cm	With flowers
20	236	Small flat leaves	Closed serration	10 x 5	Dark brown leaves	2cm	With pronounced flowers/seeds
21	318	Long curved leaves	Closed	12 x 5	Green	6cm	Rarely with flowers

Table 1: Morphological description of 24 tea clonal varieties on tea germplasm plot at CRIN, Kusuku

RESULTS AND DISCUSSION

As shown in Table 1, it was observed that 59.2% of the analyzed tea samples conformed to ISO 9768, 81.5% to ISO 5498, 77.8% to ISO 1575 and 96.3% to ISO 1576 and 100% to ISO 1577 and 85.2% to ISO 1578 respectively.

Table 4 shows that the flavour components of the clone UNK seemed to be unique. Its TF of 0.8145% and TR of 9.5% were not significantly different from black tea processed in Nyassaland with TF and TR of 0.855% and 9.5% respectively (Roberts and Smith, 1963;Owuor *et al.*, 2008). Another possible factor that could also be responsible for the different contents of TF and TR as evidenced in this study is fermentation time. Black tea processed from Nigeria appeared to have high theaflavin and thearubigin values because its fermentation timewas higher than that of Malawi tea, which is fermented for 110minutes, a fermentation time less than that used in this study (120minutes). The difference in fermentation time is reflected in the values obtained for both the TF and TR of tea from Kenya, Malawi and Nigeria (Table 5). The theaflavin

Table 2: Minimum chemical requirements for black and green tea

Characteristics	Requirement		Test method
	Black tea	Green tea	
Water extract % m/m Minimum	32	32	
Total ash % m/m			
Maximum	8	8z	
Minimum	4	4	ISO 1575
Water-soluble ash % (m/m) of total ash Minimum	45	45	ISO 1576
Alkalinity of water- soluble ash as KOH % (m/m) Minimum Maximum	1.0 3.0	1.0 3.0	ISO 1578
Acid-insoluble ash % m/m Maximum	1.0	1.0	ISO 1577
Crude fibre % m/m Maximum	16.5	16.5	ISO 5498

S/No	Sea clone	% H_20 Extract	% Total Ash	% H_20 Soluble Ash	% Acid-insoluble Ash	% Alkaline-Insoluble Ash	% Crude Fibre	% Moisture Content
1	236 under Eucalyptus	41.6	6.2	66.6	0	1.1	8.3	8.94
2	228	42	6.5	67	0	1.1	8.3	6.72
3	318	42	6.2	67	0	1.0	12.5	9.69
4	68	42	6.3	66.6	0	1.1	12.5	3.36
5	35	43.4	4.3	50	0	0.9	8.6	11.72
6	61	42	4.2	50	0	0.7	20.8	9.57
7	363	21.7	6.3	67	0	1.3	20.8	15.22
8	236(sole)	42	6.3	67	0	0.9	4.3	9.37
9	SRD 318	42	6.5	67	0	1.1	13.0	3.73
10	PRD 228	43.4	6.5	67	0	1.3	8.7	11.31
11	UNK	21.7	9.6	67	0	1.3	8.3	9.43
12	367	22.7	6.5	67	0	0.8	4.5	-
13	143	22.7	6.5	66.7	0	1.6	12.5	8.0
14	357	21.7	6.4	66.7	0	1.3	8.7	6.0
15	19	43.5	6.5	66.7	0	1.3	8.7	8.0
16	25	41.7	4.3	50	0	1.3	9.1	8.0
17	74	43.5	6.4	66.7	0	1.1	8.3	6.0
18	354	43.5	6.5	66.7	0	0.9	4.3	8.0
19	318(LL) $2^1/2$	43.5	8.5	50.0	0	1.4	9.1	6.0
20	318 (LL) $1^1/2$	45.5	6.5	66.7	0	1.5	8.7	8.0
21	China tea	22.7	6.5	66.7	0	1.4	13.6	8.0
22	Natural Hybrid tea	21.7	6.4	66.7	0	1.4	8.3	6.0
23	BT Dust –1(KK)	22.7	8.9	50.0	0	1.2	4.6	10.0
24	BT (PF) (KK)	41.7	8.7	50.0	0	1.1	8.7	8.0
25	BT (BP) (KK)	22.7	6.7	66.7	0	1.3	8.7	10.0
26	BT (BP) BA	22.7	8.9	50.0	0	1.3	16.7	10.0
27	F(KK)	22.7	15.9	28.6	0	1.0	18.2	12.0

BT: Blacktea PF: Pekoefanning BP: Brokenpekoe KK: Kakara BA: Bangoba F:Fiber
LL: Lowland SRD: Steaming,rollinganddrying
PRD: Panfixing,rollinganddrying

Table 3: Chemical components of processed black and green tea in Nigeria

S/N0		% TF	% TR	% TF: % TR
1	UNK	0.8145	9.5	0.08
2	367	0.374	8.35	0.05
3	19	0.36	7.40	0.05
4	74	0.558	12.82	0.05
5	354	1.001	9.05	0.11
6	368	1.823	9.16	0.20
7	369	0.207	17.40	0.01
8	353	0.196	5.29	0.04
9	357	0.45	7.59	0.06
10	143	0.997	16.39	0.06
11	14	0.306	9.48	0.03
12	238	0.997	10.95	0.09
13	108	0.198	8.85	0.02

%TF = 6.25 x E_c x f_1; % TR = 12.E_D + 6.25 (E_A – E_c) x f_2

Table 4: Clonal variation in the theaflavin (%) and thearubigin (%) contents of black teas

Particular	Source	Fermentation	Time
Theaflavin (μmole/g)	Kenya	110 min.	27.2
	Malawi	110 min.	21.5
	Nigeria	120 min.	22.3
Thearubigin (%)	Kenya	110min	15.5
	Malawi	110 min.	9.21
	Nigeria	120 min.	10.04
Brightness (%)	Kenya	110 min.	25.8
	Malawi	110 min.	22.5
	Nigeria	120 min.	15.7

Table 5: Comparison of quality of black tea from Nigeria to tea from other tea-producing countries of the world due to fermentation time

of Nigerian black tea was second to that of Kenya, which is known globally for producing very high quality black tea. The TFtrends were in the following order: Kenya (27.2µmole/g) > Nigeria (22.3µmole/g) > Malawi (21.5µmole/g). Clone UNK showed a higher value than the TF reported by Roberts and Smith (1963) and Owuor*et al.*(2008) for Malawi tea. Although the fermentation time used for the Malawi tea was the same asthat used in Kenyan tea, a similar TF percentage to Malawi tea and a lower TF than Nigerian tea would be expected, but this was not the case. This result could be due to differences in the clonal properties of fresh tea leaves in the processing of black tea from the three countries. The method of black tea processing used in this study is different from the popular CTC method, yet the quality is not significantly different from some tea processed using this method. The $E_{380}//E_{460}$ ratio of CTC processed tea is a good index of quality and the tea processed in Nigeria did not differ significantly from the ratio of CTC manufactured BP (Broken pekoe) grade in NE India. Some values of TF and TR are also considered query grades due to their high TF or TR values when compared to the normal good grade values (Roberts and Smith, 1963). Clone 368, with % TF= 18.3%, was considered a query grade, since its value is higher than query grade black tea of 1.63%TF from South India, as reported by Roberts and Smith (1963).Theseexaggerated values could be due to analytical error. The values for TF and TR in black tea used in this study are not significantly different from tea from other countries,including India and SriLanka, producing Ceylon tea. The % TR of black tea in Nigeria was not significantly different from medium-quality tea from Sri Lanka. Clone 19,with TF at 0.36%, is also not significantly different from the BP grade of Ceylon tea. At 7.4%TR for the same clone 19, this value is also similar to theTR percentage of query grade tobacco cut manufactured black tea from South India (Maria *et al.*, 2004). Some of the quality values for black tea in Nigeria, such as TF and TR, also compared favourably with tea from Russia. Clone 14 results showedTF (0.31%) and TR (9.48%) values that were not significantly different from a sample of black tea from Russia (TF 0.33%, TR, 9.5%), which is a quality regarded as plain tea. The colour brightness percentage (CBR) of clone 14 (15.9%) comparesfavourably with the CBR of tea conventionally processed in Nyassaland with a CBR value of 18.8%, which was prepared with distilled water. This indicates that water used in the preparation of tea infusion can have a significant influence on the characteristic colour brightness of tea. Thesecolour brightness results were also not significantly different from those of Assam orange pekoe prepared with mains water(15.0%). Clone 143 also followed this trend

in colour brightness (CBR = 18.7%). Clones 143 and 238, with %TF of 0.97%, are not significantly different from CTC manufactured tea (PF grade), having 1.0% TF and 16.39% TR. These values were obtained after 120 minutes fermentation of CTC manufactured tea, which is similar to the fermentation time used in this study. When comparing black tea produced in China, the TF of Nigerian clone 357 used in this study is higher (0.45%) than LapsongSouchoung (0.19%) without significant differences in TR,clone 357 having 7.59% and LapsongSouchoung 7.8%.Clone 108 had 353% TF = 0.196, which is favourably comparable with LapsongSouchoung from China

CONCLUSION

This study has established the conformance of both green and black tea produced in Nigeria to international standards. The quality of the black tea comparesfavourably with black tea from other leading black tea processing countries of the world,including India, Sri Lanka, Nyassaland, Russia and China.

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