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Phytopharmaceutical properties of herbal teas circulating in the Nigerian market

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We report herein some phytopharmaceutical properties of commonly marketed teas in Nigeria. The organoleptic and physicochemical properties such as color, odor, physical appearance as well as ash value, moisture content, flow properties, pH and solubility were interrogated using standard methods as the measure of their phytopharmaceutical properties. The results show that, all the teas were coarse in nature and the colors ranged from green to brown. Most of the teas are pleasant to minty odor, while the tastes ranged from minty, sweet, bitter to tasteless. The ash values obtained were between 0.7 and 1.00. The pH values ranged between 4.23 and 7.89 with cold infusions having higher pH values than the hot infusions. All the teas investigated had angles of repose between 17.13 and 35.81°, Carr's index between 4.65 to16% and Hausner quotient between 1.08 and 1.19; they also had moisture content ≤ 10% suggesting adequate processing and storage requirements. The teas investigated had variable physicochemical properties which underscores the need for standardization of teas before approval by regulatory authorities.

Key words: Teas, phytopharmaceutical properties, standardization.

INTRODUCTION

Teas originated from plant *Camellia sinesis*; they are indigenous to Chinese and Indians. Teas are the second most widely consumed beverage globally after water and can be prepared as cold or hot infusions (Dufresne and Farnworth, 2001; Sharma et al., 2005). Herbal teas, on the other hand look like teas and is brewed same way but are not considered tea because they do not originate from the *Camellia sinensis* plant. Herbal teas are more precisely known as *'tisanes'* connoting they are derived from blends of dried leaves, seeds, grasses, nuts, barks, fruits, flowers, or other botanic sources (Kara, 2009; Ravikumar, 2014). Teas and herbal teas do not only serve as refreshing drinks but also have some medicinal values.

A variety of compounds such as polysaccharides, antioxidants and et al., 2014); this is unassociated with

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the high polyphenol content they possess. In Nigeria, leaves such as bitter leaf, "Utazi" and "Uziza" have been effectively utilized for the manufacture of herbal teas due to their medicinal properties (Okafor et al., 2009). However, most teas circulating in the Nigerian market are imported.

Herbs and herbal products are significantly used in the health care system in the developing countries and have become even more widespread due to the generally poor state of public health institutions in these countries. However, the major limitation to their use remains lack of standardization (Emeje et al., 2005). Standardization of teas is very essential since it is being consumed as a type of medicinal preparation; evaluation of factors that determine the quality of teas such as the plucking method, fermentation time, sorting, particle size and organoleptic assessments among others (Gill et al., 2011) become necessary to improve acceptability of the tea products and safe guard the health of the consumers. Furthermore, a direct correlation has been reported between the quality of teas and the content of polyphenols, amino acids and caffeine in the teas (Khalid et al., 2011).

Although, teas possess constituents useful for eliminating toxic substances from the body, a recent study by Jaâfoura et al. (2014) reports that consumption of certain teas could be linked to dental erosions. A similar study also reported that some tea extracts were acidic (pH between 4.8 and 5.3) although their solubility profiles were similar (Chen et al., (2012). In a different study, Naithani and Kakkar (2004) assessed the physical and chemical properties of some Indian herbal teas and reported the presence of organochlorine pesticides as contaminants; this corroborates the need for quality assessment of teas so as to secure the health of consumers.

Therefore, this study was conducted to evaluate the organoleptic and physical-chemical properties of teas (teas and herbal teas) circulating in the Nigerian market.

MATERIALS AND METHODS

Thirty-one samples of teas comprising of green, black and white teas were purchased from different Supermarkets in Abuja, Federal Capital Territory (FCT), Nigeria. All the solvents used were of analytical grade. The teas were assigned codes T1 to T31 for ease of documentation.

Organoleptic properties

A subjective analysis of the taste, odor, color and texture of the teas was done by three (3) healthy volunteers.

Moisture content determination:

Three (3) gram each of the teas were transferred into petri-dishes and then placed in an oven maintained at a constant temperature of 54°C until a constant weight was obtained. The samples were allowed to cool and weighed. The moisture content (%) was then determined using the following formula:

$$final\ weight - initial\ weight \Big/ _{initial\ weight}\ X\ 100 \quad (1)$$

Ash content

The AOAC (1995) method was employed. One gram (1 g) of each tea sample was incinerated in a muffle furnace for about 6 h at 600°C. The residue after burning was cooled and weighed. This test was done in triplicate and the mean ash content was determined.

Flow rate/angle of repose

One (1) g each of the tea samples was poured through a funnel that has been mounted on a retort stand. The time taken (seconds) for each sample to pass, through the orifice of the funnel was recorded and the flow rate was determined as, ratio of weight to time. The height of the sample heap and the radius of the base heap were recorded and the angle of repose (°) was calculated as:

$$A = \tan^{-1}\frac{h}{} \quad (2)$$

Determination of bulk and tapped density

Ten (10) g of each tea was weighed into a 100 ml measuring cylinder, the volume occupied was recorded as the bulk volume from which the bulk density was calculated. The cylinder was then tapped 100 times in the Stampfvolumeter (Stav, 2003); the volume obtained was used to determine the tapped density. These parameters were determined in triplicates.

Carr's index and Hausner ratio

These parameters were computed from the bulk and tapped densities.

$$Carr's\ index\ (\%) = \frac{tapped\ density - bulk\ density}{tapped\ density} X\ 100 \quad (3)$$

$$Hausner\ ratio = \frac{tapped\ density}{bulk\ density} X\ 100 \quad (4)$$

Determination of pH

One (1) gram of each tea was infused in 10 mL of cold water for 30 min; the suspension was filtered and the pH was determined using AR10 pH meter. This was repeated by infusing the teas in hot water.

Determination of solubility

Qualitative method was employed. One (1) gram of the teas was dispersed in 10 mL of water in a test tube, agitated and left to stand undisturbed for 30 min. visual observations were made and the procedure was repeated for teas dispersed in ethanol.

Figure 1. Photograph of the herbal teas assessed.

RESULTS AND DISCUSSION

A picture of the evaluated tea samples is shown in Figure 1, while the results of organoleptic (sensory) evaluation of the teas are presented in Table 1. contrary to videos circulating the social media on worm-infested teas in circulation, physical and microscopic examination of the teas did not reveal the presence of worms, animal feces, metals or any other extraneous dangerous material. However, organoleptic properties of the teas varied significantly; no two teas had exactly the same properties. This is expected because these teas are from different sources and contain different chemical components responsible for their physical characteristics. Furthermore, they are produced by different manufacturers via different processes and extraction methods.

Odor is a quality that foretells acceptance or rejection of a type of tea and is linked to the presence of various aroma compounds and to the manufacturing processes employed (Chaturvedula and Prakash, 2011). Most of the tea samples evaluated were found to have pleasant odor while none had an offensive odor, this indicates high acceptability by consumers. Taste is also a determinant of acceptability and the different degrees of taste could be attributed to the presence of chemical compounds present in the teas. Tea samples T4, T7, T11, T12, T21, T22 and T31 were observed to be sweet; this could be due to the presence of some sugars (polysaccharides) in the tea as reported earlier by Nakagawa (1975). The bitter tastes of some of the teas (T3, T5, T6, T16, T28 and T29) may be attributed to the contents of catechins, caffeine and amino acids as speculated by Chaturvedula and Prakash (2011).

The colors of the teas usually vary due to climate and method of processing however, other constituents of tea such as theaflavins and thearubigins have also been reported to affect the color of teas (Owuor and Obanda, 2001). The colors of teas in this study were observed to oscillate between shades of green and brown and all the tea samples had generally coarse texture. These results show that the organoleptic characteristics of the tea samples differed as expected.

The bulk and tapped density are indirect tools of measuring flowability of a material. The bulk densities of the teas were between 0.12 and 0.55 g/mL (Table 2). Tea sample T4 was found to have the lowest bulk densities (0.12 g/mL) while T9 had the highest (0.55 g/mL); the tap density on the other hand ranged between 0.15 and 0.66 g/mL. The reduction in tea mass with tapping was due to displacement of voids and particle re-arrangement in the tea sample on tapping.

The flow rate of all teas shown in Table 2, varied greatly (0.52 to 22.22 g/sec) and this could be attributed to the different sizes and shapes of the tea leaves. The angle of repose which is a measure of the flowability of materials shows that all the teas had good flow with the highest value being < 35°. However no value was

Table 1. Organoleptic properties of teas.

Code	Taste	Colour	Odor	Texture
T1	Tasteless	Light green	Pleasant	Coarse
T2	Tasteless	Black	Pleasant	Coarse
T3	Bitter	Green	Pleasant	Coarse
T4	Sweet	Green	Pleasant	Rough
T5	Bitter	Dark green	Pleasant	Rough
T6	Bitter	Grey	Pleasant	Rough
T7	Sweet	Dark brown	Pleasant	Coarse
T8	Mint	Brown	Cooling	Coarse
T9	Tasteless	Light green	Pleasant	Rough
T10	Tasteless	Light brown	Pleasant	Coarse
T11	Sweet	Light green	Sharp	Rough
T12	Sweet	Light green	Pleasant	Rough
T13	Tasteless	Dark brown	Pleasant	Coarse
T14	Tasteless	Brown	Odorless	Granular
T15	Mint	Dark brown	Pleasant	Rough
T16	Bitter	Green	Pleasant	Coarse
T17	Tasteless	Dark green	Minty	Coarse
T18	Tasteless	Brown	Pleasant	Coarse
T19	Tasteless	Brown	Pleasant	Coarse
T20	Tasteless	Brown	Unpleasant	Coarse
T21	Sweet	Brown	Pleasant	Coarse
T22	Sweet	Green	Pleasant	Coarse
T23	Tasteless	Brown	Odorless	Coarse
T24	Tasteless	Dark green	Pleasant	Coarse
T25	Tasteless	Lemon green	Pleasant	Coarse
T26	Hot	Dark green	Minty	Coarse
T27	Tasteless	Brown	Pleasant	Coarse
T28	Bitter	Brown	Pleasant	Coarse
T29	Bitter	Lemon green	Unpleasant	Coarse
T30	Tasteless	Brown	Pleasant	Coarse
T31	Sweet	Brown	Pleasant	Coarse

recorded for sample T20 because it was found not to flow, due to its rod-like shape which obstructed its flow. Carr's index is a parameter that examines the ability of the powder to reduce in volume under pressure while Hausner ratio gives assessment of the degree of friction between particles in a powder. Sample T3 had the highest Carr's index (20.00%) and a corresponding high degree of friction (1.25). This shows a non-free flowing sample attributable to its small size and cohesive particles; this corroborates the findings of the flow rate and angle of repose.

The pH value of the teas were significantly different in cold and hot water. Cold water infusions had values between 4.23 and 7.89 while the hot water infusion was between 5.09 and 7.20 (Table 3). This shows that cold water infusions were more acidic than the hot decoctions and is in relation with studies by Phelan and Rees (2003) that reported same and added that, consumption of acidic teas has potential of wearing off tooth enamel leading to dental problems. In a similar but different study, Kreulen et al. (2010) opined that, there was an upsurge in the incidence of tooth erosions among youth consuming teas which is assumed to be acidic. High consumption of teas can impact on the dental enamel by causing demineralization of the tooth (Zero, 1996). This study lends its voice to others recommending that teas should be taken while still hot.

Ash content is a measure of inorganic residues of plant materials which remains after water and organic matter has been removed by heating. The ash content of all tea samples (Table 3) ranged between 0.72 and 1.01 with T20 having the lowest value of 0.72% and T23 the highest content (1.01%).

Ash content is closely linked to mineral content which portrays the quality of that material. Teas with ash contents < 5.5% are said to be of high quality which

Table 2. Flow properties of teas.

Code	Flow rate (g/s)	Angle of repose (O)	Bulk density (g/mL)	Tapped density (g/mL)	Hausner ratio	Carr's Index (%)
T1	1.25 ± 0.34	29.33 ± 3.70	0.28 ± 0.00	0.32 ± 0.01	1.12 ± 0.04	12.50
T2	12.31 ± 11.30	17.18 ± 1.08	0.44 ± 0.02	0.49 ± 0.01	1.13 ± 0.06	10.20
T3	2.56 ± 0.13	24.48 ± 2.81	0.35 ± 0.01	0.38 ± 0.00	1.09 ± 0.02	7.89
T4	0.53 ± 0.09	35.87 ± 4.45	0.13 ± 0.00	0.15 ± 0.00	1.17 ± 0.02	13.33
T5	0.70 ± 0.09	34.84 ± 3.72	0.17 ± 0.00	0.20 ± 0.00	1.17 ± 0.03	15.00
T6	0.19 ± 0.01	24.85 ± 3.14	0.24 ± 0.01	0.26 ± 0.01	1.05 ± 0.03	7.69
T7	14.70 ± 2.09	23.69 ± 2.77	0.40 ± 0.02	0.45 ± 0.01	1.13 ± 0.05	11.11
T8	3.70 ± 1.51	25.66 ± 2.97	0.33 ± 0.01	0.38 ± 0.01	1.15 ± 0.04	13.16
T9	0.55 ± 0.02	26.04 ± 2.69	0.21 ± 0.00	0.25 ± 0.00	1.18 ± 0.02	16.00
T10	23.99 ± 6.87	17.55 ± 1.65	0.56 ± 0.00	0.67 ± 0.00	1.20 ± 0.00	16.42
T11	1.26 ± 0.63	30.40 ± 4.23	0.30 ± 0.02	0.35 ± 0.01	1.17 ± 0.06	14.29
T12	1.56 ± 1.19	28.42 ± 2.58	0.30 ± 0.01	0.36 ± 0.01	1.19 ± 0.04	16.67
T13	16.32 ± 1.61	19.59 ± 2.61	0.43 ± 0.01	0.47 ± 0.01	1.09 ± 0.00	8.51
T14	18.11 ± 3.01	18.91 ± 0.62	0.47 ± 0.03	0.51 ± 0.02	1.08 ± 0.03	7.84
T15	8.64 ± 0.73	26.15 ± 3.99	0.32 ± 0.01	0.36 ± 0.01	1.12 ± 0.02	11.11
T16	7.63 ± 2.15	27.30 ± 1.03	0.40 ± 0.00	0.45 ± 0.01	1.12 ± 0.03	10.67
T17	10.31 ± 2.96	24.70 ± 2.43	0.44 ± 0.01	0.49 ± 0.01	1.12 ± 0.03	10.28
T18	7.07 ± 1.84	24.90 ± 1.50	0.42 ± 0.00	0.48 ± 0.00	1.14 ± 0.00	12.50
T19	7.66 ± 2.09	25.80 ± 1.00	0.37 ± 0.00	0.42 ± 0.00	1.13 ± 0.00	11.20
T20	No flow	No flow	0.22 ± 0.03	0.25 ± 0.00	1.14 ± 0.02	11.94
T21	8.35 ± 1.19	28.50 ± 2.00	0.36 ± 0.01	0.42 ± 0.00	1.15 ± 0.02	13.23
T22	4.30 ± 1.17	27.30 ± 1.02	0.32 ± 0.02	0.35 ± 0.01	1.12 ± 0.02	10.50
T23	8.98 ± 1.07	26.30 ± 0.60	0.39 ± 0.01	0.42 ± 0.00	1.06 ± 0.02	5.23
T24	5.82 ± 0.68	25.60 ± 2.10	0.38 ± 0.01	0.42 ± 0.00	1.10 ± 0.02	8.83
T25	2.01 ± 0.41	27.90 ± 0.90	0.27 ± 0.01	0.32 ± 0.01	1.18 ± 0.05	15.11
T26	6.90 ± 1.28	25.48 ± 1.20	0.35 ± 0.01	0.39 ± 0.01	1.10 ± 0.02	9.40
T27	5.90 ± 0.49	27.20 ± 1.30	0.32 ± 0.01	0.38 ± 0.00	1.19 ± 0.04	16.07
T28	8.15 ± 2.25	25.10 ± 1.05	0.38 ± 0.01	0.42 ± 0.01	1.11 ± 0.05	10.07
T29	2.91 ± 0.32	32.50 ± 1.60	0.21 ± 0.00	0.25 ± 0.00	1.16 ± 0.03	14.07
T30	8.00 ± 0.66	26.50 ± 2.34	0.35 ± 0.01	0.39 ± 0.01	1.10 ± 0.05	9.36
T31	7.83 ± 2.18	27.00 ± 1.77	0.4 1± 0.01	0.43 ± 0.00	1.07 ± 0.03	6.72

would be maintained during storage (Rehman et al., 2002).

Therefore, low values observed in this study indicate, minimal contamination during processing and purports high quality and purity of the tea samples. Moisture content is one of the factors that can affect the quality of a product and teas had moisture contents as high as 10%.

This disparity could be as a result of the diverse method of tea manufacture, improper packaging and storage conditions which could foster absorption of moisture. The presence of high moisture content (> 12%) can encourage the growth of mould which lead to deterioration of various consumed products including teas (Handbook of Pharmaceutical Excipients, 2006; Rashid and Kurt, 2013).

Dehydrated herbal preparations have been reported to have acceptable moisture content of 5 to 10% by Miller (1998); Walsh and Fongemie (2003) to while black teas have been recommended to have moisture content ≤ 3% (Temple et al., 2001). In this present study, all teas had moisture contents within the acceptable range for herbal preparations showing adequate processes of drying, and suitable packaging for storage was used.

Water is the common solvent used in making tea, however, Bhebhe et al (2016) reports that, hot water and in some cases aqueous organic solvents, extract appreciable amounts of phenolic compounds for pharmacological action than cold water and pure organic solvents.

This was corroborated in this study that, teas made with ethanol were found to have deeper colors than those infused in cold water indicating that more constituents were extracted into ethanol than water (Table 3).

Table 3. Some other physical parameters of teas.

Code	Moisture content (%)	Ash value (%)	pH		Solubility	
			Cold	Hot	Water	Ethanol
T1	3.3	0.88	6.15 ± 0.06	5.65 ± 0.12	**	**
T2	0.0	0.91	4.45 ± 0.24	0.49 ± 0.01	*	*
T3	6.6	0.91	5.11 ± 0.17	6.17 ± 0.18	*	**
T4	6.6	0.84	4.58 ± 0.25	5.93 ± 0.09	**	**
T5	3.3	0.90	6.51 ± 0.32	6.13 ± 0.15	*	**
T6	6.6	0.88	4.28 ± 0.14	5.49 ± 0.17	*	**
T7	10.0	0.83	5.17 ± 0.09	5.24 ± 0.41	**	**
T8	10.0	0.90	4.58 ± 0.38	6.03 ± 0.25	*	**
T9	3.3	1.00	5.72 ± 0.04	6.79 ± 0.20	**	**
T10	3.3	0.94	4.23 ± 0.17	5.74 ± 0.10	**	**
T11	3.3	0.92	5.01 ± 0.01	6.02 ± 0.02	**	**
T12	3.3	0.99	5.06 ± 0.23	7.20 ± 0.12	**	**
T13	6.6	0.97	4.37 ± 0.21	6.24 ± 0.07	**	**
T14	3.3	0.97	5.04 ± 0.05	5.63 ± 0.35	*	**
T15	0.0	0.90	4.77 ± 0.00	4.97 ± 0.35	**	**
T16	5.0	0.93	5.72 ± 0.20	5.72 ± 0.20	*	*
T17	3.7	0.91	6.38 ± 0.05	6.47 ± 0.30	**	*
T18	2.7	0.90	5.39 ± 0.40	6.30 ± 0.20	*	*
T19	4.3	0.72	5.54 ± 0.30	5.69 ± 0.02	**	*
T20	2.0	0.76	5.69 ± 0.09	6.34 ± 0.04	**	*
T21	4.0	0.91	5.79 ± 0.10	5.09 ± 0.05	**	*
T22	3.0	1.01	5.32 ± 0.30	5.29 ± 0.04	**	*
T23	4.3	0.92	5.33 ± 0.08	7.06 ± 0.10	**	*
T24	4.6	0.89	5.14 ± 0.20	5.04 ± 0.03	**	**
T25	4.0	0.93	5.95 ± 0.03	6.88 ± 0.09	**	*
T26	5.7	0.93	5.70 ± 0.40	6.38 ± 0.30	**	*
T27	4.6	0.89	5.31 ± 0.20	5.63 ± 0.04	**	*
T28	4.6	0.90	7.06 ± 0.02	6.19 ± 0.20	*	*
T29	4.3	0.84	7.89 ± 0.30	6.22 ± 0.20	**	*
T30	2.0	0.84	5.15 ± 0.10	5.28 ± 0.07	*	*
T31	2.3	0.93	6.98 ± 0.03	6.44 ± 0.10	**	*

*Light colored; **, dark colored.

Conclusion

This study shows that teas have different physico-chemical properties which may affect their quality. The popularity of teas across the globe calls for standardization to avoid, creating a public health disaster in future.

Conflict of interest

The author has not declared any conflict of interests.

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