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Compositional analysis of Turmeric types cultivated in Sri Lanka and India

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Abstract
Turmeric, *"Curcuma longa"* is one of the major spices and colouring agents widely consumed throughout the world. Two Indian samples and three Sri Lankan market samples were collected and named them as Indian 1 (Imported from India & samples were collected from Petta market Colombo), Indian 2 (Imported from India & samples were collected from a local city Matale) and Local 1(Collected from a local market), Local 2 (Collected from an Export Agriculture Research Institute, Matale) and Local 3 (Collected from a home garden). Proximate analysis of each turmeric type was conducted at Export Agriculture Research Institute -Matale and University of Sri Jayewardenepura, Sri Lanka, pertaining to moisture, Protein, fibre, Total Ash, Acid insoluble Ash, minerals and oleoresins. Results revealed that proximate compositions were in a range such as moisture, protein, fibre, total ash, acid insoluble ash and oleoresin contents (12.40 - 11.33) %, (8.53-7.60) %, (7.90-7.20) %, (7.70-6.70) %, (1.80-1.10) %, and (15.87-14.20) % respectively. The mineral content was analysed using Atomic Absorption Spectroscopy and results pertaining to Na, K, Fe, and Cu contents were in the ranged of (32-35), (1603-2402), (32-38) and (0.62-0.73) mg/100g respectively.

Keywords: Minerals, moisture, oleoresin, protein, turmeric

1. Introduction
Turmeric is a prominent spice found particularly in Asian countries including India and Sri Lanka too. It is obtained from the rhizome of the plant *Curcuma longa* which belongs to the Zingeberacaea family [1]. Turmeric is very popular for its aroma and colour. The colour of turmeric powder ranges from bright yellow to Orange yellow. Because of the brilliant yellow colour, turmeric is known as Indian Saffron [2]. Turmeric powder is widely used in food industry as a spice, food colouring agent and as a preservative. Turmeric has a long history for its specific features such as antioxidant, antimicrobial, antifungal, anti-inflammatory and digestive properties [3]. The underground rhizome that is commercially processed into the spicy powder, consists of two distinct parts. The egg-shaped primary or mother rhizome is an extension of the stem. Several long cylindrical multi-branched secondary rhizomes grow downward from the primary rhizome [4]. In Sri Lanka, turmeric is cultivated for the local consumption only. But in India, turmeric is cultivated in a large scale for the export purpose. Apart from India, countries like China, Bangladesh, Indonesia and Brazil also cultivate turmeric in commercial purposes.

2. Materials and Method
2.1 Plant material
Indian turmeric samples were collected from Colombo-Pettah market and Matale local-market while local turmeric samples were collected from Matale local market, National Spice Garden of the Export and Agricultural Research Institute, Matale and a local home garden at Matale town. The five different types of turmeric samples were ground using a small grinder which was used only for the grinding purpose of turmeric. Turmeric rhizomes were ground for 2 minutes until passing through 1mm diameter aperture. Then the samples were labelled and were preserved in dry stoppered containers (I.S Specification No I.S 1797 – 1985 Methods of Test for Spices and Condiments / A.O.A.C 17th edn 2000, Official Method 920.164 Preparation of Test sample).

2.2 Analytical Methods
According to methods stated in Association of Official Analytical Chemists17th edition 2000, test methods for spices analytical determinations were performed. Values were expressed as the mean standard deviations for triplicates. The statistical analysis of data was determined using ANOVA to determine the significance of each parameter (α=0.05) and followed by

comparison among the types using the Turkey test by the statistical software MINITAB R 17.

2.2.1 Moisture content
Dean and Stark Toluene Distillation Method was used to determine the moisture content of ground turmeric (A.O.A.C 17th edition 2000 Official Method 986.21, Moisture in Spices). Toluene is used as the organic solvent to determine the water content. Water collected in the graduated tube indicates the amount of water

2.2.2 Protein content
Protein content of turmeric was determined by using Micro Kjeldhal method stated in A.O.A.C method 960.52. Therein 30 mg of sample of turmeric powder was digested in Kjeldhal kit (VELP SCIENTIFICA – UDK 129) for nearly 3 hours. After neutralization in the Kjeldhal instrument, released condensed fume was trapped in to 4% Boric acid solution which was used then to titrate against with 1 M HCl. Protein content of turmeric was calculated using nitrogen conversion factor 6.25 (Al-Gaby, 1998) and data were expressed as percent of dry weight.

2.2.3 Fiber
I.S Specification No I.S 1797 – 1985 Methods of Test for Spices and Condiments was followed to determine fiber content in turmeric which were defatted by using Soxhelt extraction. Thereafter, the defatted samples of turmeric were digested by boiling Sulphuric acid (acid digestion) and Sodium hydroxide (base digestion) solutions in a flask connected to a water-cooled reflux condenser. After washing the digested samples, they were kept in the oven at 105±1°C for 3 hours for drying. Then the dried samples were incinerated in muffle furnace (Wise Therm) at 550±25° C until all carbonaceous matter is burnt. Final weight difference was used to calculate fiber content in which expressed as percent of dry weight.

2.2.4 Ash and mineral content
Organic matter in turmeric samples was removed by igniting and then incinerating by placing 2g of powdered samples in the muffle furnace (Wise Therm) at 550^0C for 3-4 hours. Ash content was determined as mentioned in A.O.A.C Method 941.12 and acid insoluble ash was determined by washing with diluted HCl according to test method mentioned in I.S Specification no I.S 1797–1985, Methods of Test for Spices and Condiments. Mineral constituents Na, K, Fe, Cu, were determined using Atomic Absorption Spectrophotometer (Thermo Scientific Ice 3000 series) using standard solutions of relevant elements.

2.2.5 Oleoresin content
Oleoresin was extracted from turmeric rhizomes using the method described by Green *et al*., (2008) [5] Initially 50g of the powdered sample was taken into a 2 L round bottom flask and 700ml of 95% ethanol was added. A condenser was fitted with the round bottom flask and it was submerged in a water bath where the temperature had been set to 80^0C. The reflux was done for 6 hours followed by vacuum filtration of the solution and re –extraction of the residue for 2h with 300ml of ethanol. The filtrate was concentrated using a rotary evaporator in a water bath at 50^0 C to form the oleoresin and its weight was measured and oleoresin content is expressed as percent of dry weight.

3. Results
3.1 Moisture content of turmeric rhizomes
Mean moisture content and standard deviations of 5 types of Turmeric rhizome samples is illustrated in the table 1

Table 1: Mean moisture content of turmeric rhizomes.

Turmeric Type	Moisture percentage-Dean and stark method (DS) %	Moisture content- Moisture meter method (MM) %
Indian 1	11.33^a+0.15	11.33^a+0.06
Indian 2	11.56^b+0.15+0.15	11.53^b+0.11
Local 1(Matale)	11.66^c+0.11	11.90^c+0.10
Local 2 (Research centre)	12.16^d+0.15	12.40^d+0.10
Local 3(Home garden Matale)	12.36^e+0.06	12.43^e+0.06

Data presented as mean values for triplicates ± S.D (n=3) a, b, c, d, e letters in same column are significantly different at (p< 0.05) level.

According to the data given in table1, the home garden sample (HM) had the highest moisture content- 12.36% with the least standard deviation of ±0.057. The least moisture content was recorded by the Indian sample 1 from the pettah market with the value of 11.33±0.15%. The data clearly indicate that the moisture content of the local turmeric types is higher than that of the Indian types. The prevailing climatic conditions, the processing techniques and the time period after harvesting may be influencing for the moisture content. When comparing the moisture content readings obtained from Dean and Stark method and the moisture meter method, readings taking from moisture meter is little bit higher than that of the Dean and Stark method. When the moisture content is measured using moisture meter, a direct reading is given. But in Dean and Stark method, the reading is indirect. Therefore there may be a little variance between the results from both methods. According to the readings of moisture meter, the highest moisture percentage is recorded by the local 3 sample (Home garden – Matale) with 12.43±% and the lowest given by the Indian 1 sample with 11.33±0.05%. When comparing the standard deviations, the moisture reading from moisture meter method having a less deviation than the Dean and Stark method. The high sensitivity of the moisture meter may be the reason for the accurate moisture measurements. Ikpeama *et al*., (2014) [6] state that the moisture content of turmeric rhizomes was about 8.92%. However, moisture contents obtained from this study for all types of Turmeric are higher than the above value. Nizar *et al*., (2015) [7] have reported that the moisture content of turmeric was 13.2% and this value is in compliance with the value obtained for 5 types of Turmeric rhizomes.

The results obtained from the study were analysed according to one way of parametric ANOVA and outcome of it revealed that there is a significant difference between the moisture contents of 5 turmeric types. These results indicate that the moisture content of final product is depending on the various factors such as geographical factors, temperature of the cultivation areas, processing conditions like drying time, method of drying etc. According to Braga *et al* (2006) [8], low moisture content contributes to low water activity as well as low microbial activity. If water activity of Turmeric rhizomes is less than 0.91. they can keep in the market for a long time.

3.2 Protein content of turmeric rhizomes

Protein content of five type of turmeric rhizomes were analysed and outcome that are given in the table 2.

Table 2: Protein content of 5 types of turmeric rhizomes

Type	Protein content%
Indian 1	$8.43^{a} \pm 0.05$
Indian 2	$8.53^{b} \pm 0.28$
Local 1	$7.86^{c} \pm 0.05$
Local 2	$8.36^{d} \pm 0.25$
Local 3	$7.63^{e} \pm 0.25$

Data presented as mean values for triplicates ± S.D (n=3) a, b, c, d, e letters in same column are significantly different at (p< 0.05) level.

The outcome of the analysis given in the table 2 shows that, Indian 2 occupies the highest protein content of 8.53% and the sample of local 3 (Home garden Matale) occupies the lowest percentage of 7.63%. These values are slightly smaller than the finding of Ikpeama *et al.* (2014) [6]. According to them, crude protein content of turmeric rhizomes is about 9.42%. But according to Jaggi Lal *et al*., (2012) [1] the protein content is 8.5%. Hence, values obtained by this research are in compliance with the findings cited in the literature. Statistical analysis of the data revealed that there is a significant difference among protein contents in five types of Turmeric Rhizomes (p<0.05).

3.3 Fibre content of turmeric rhizomes

The table 3 presents the mean values and Standard deviations of the fiber content in turmeric rhizomes of the 5 different types

Table 3: The fiber content of the 5 different turmeric rhizomes.

Type	Fibre content %
Indian 1	$7.20^{a} \pm 0.09$
Indian 2	$7.44^{b} \pm 0.09$
Local 1	$7.92^{c} \pm 0.05$
Local 2	$7.76^{d} \pm 0.13$
Local 3	$7.60^{e} \pm 0.03$

Data presented as mean values for triplicates ± S.D (n=3) a, b, c, d, e letters in same column are significantly different at (p< 0.05) level.

According to data given in the table 3, the highest fibre percentage is represented by the sample of Local 1 and the value is 7.92%. The lowest fiber content is denoted by the sample of Indian 1 and the value is 7.20%. Thus, Indian sample contains a lower fiber content than the Sri Lankan samples. According to one-way parametric ANOVA, there is a significant difference between fiber contents and the 5 types of Turmeric rhizomes (p<0.05). It has been found that the mean fiber content of the turmeric samples from Brazil is 7.2% [9]. So, the values for the fiber content from this research tallies with these findings. However, according to Nizar *et al*., [7] the fiber content is 4.80% which shows somewhat slight difference in fiber content in comparison with the data obtained from this study.

3.4 Total ash and acid insoluble ash

Table 4: Total Ash Content of the Turmeric Rhizome of 5 different types

Type	Total Ash content (%)
Indian 1	$7.30^{a} \pm 0.18$
Indian 2	$7.56^{b} \pm 0.09$
Local 1	$6.72^{c} \pm 0.25$
Local 2	$7.79^{d} \pm 0.16$
Local 3	$8.80^{e} \pm 0.23$

Data presented as mean values for triplicates ± S.D (n=3) a, b, c, d, e letters in same column are significantly different at (p< 0.05) level.

According to the data given in table 4, the highest total ash content is denoted by the local sample 3 and that value is 8.80% and the least value is denoted by the local 1 sample which has the value of 6.72%. According to the Tukey Simultaneous Test at 95% confidence level, there is a significant difference between the total ash content of the 5 different turmeric types. According to the Standards of Food and Agriculture Organization (FAO), the maximum allowable amount of total ash content is 9%. So, all the samples in this research giving a less Total Ash Content than the maximum limits given by FAO.

3.5 Acid insoluble ash content of turmeric

Table 5: Acid insoluble ash content in the rhizomes of 5 different turmeric types.

Type	Acid Insoluble Ash Content (%)
Indian 1	$1.48^{a} \pm 0.38$
Indian 2	$1.31^{b} \pm 0.08$
Local 1	$1.13^{c} \pm 0.05$
Local 2	$1.30^{d} \pm 0.06$
Local 3	$1.85^{e} \pm 0.08$

Data presented as mean values for triplicates ± S.D (n=3) a, b, c, d, e letters in same column are significantly different at (p< 0.05) level.

According to the data given in the table 5, the highest acid insoluble ash percentage is recorded by the local 3 sample and the value is 1.85%. The lowest acid insoluble ash content is denoted by the sample of Local 3 corresponding value of it is 1.13%. The Indian type 1 and 2 contained "acid insoluble ash" 1.477% and 1.310% respectively. Acid insoluble ash value gives a clear indication about the authenticity of the product. Himesh *et al*., (2011) [10] state that high acid insoluble ash value is due to the silica present in the sample. Apart from that, the harvesting, drying and processing techniques are also affecting to the percentage of acid insoluble ash content. Since the home garden sample is not a market sample, it is not processed properly. So, there may be sand along with turmeric rhizomes that may contribute for the higher value. According, to ANOVA, at 95% confidence level, there is a significant difference among the acid insoluble ash content in the 5 different types.

3.6 Mineral content of turmeric

Table 6: Mineral composition of the turmeric rhizomes of 5 different types

Mineral	Indian1	Indian 2	Local 1	Local 2	Local 3
Sodium	$32.66^{a} \pm 1.15$	$35.66^{a} \pm 1.528$	$32.00^{a} \pm 2.65$	$33.33^{a} \pm 2.08$	$35.00^{a} \pm 3.61$
Potassium	$1603^{a} \pm 181$	$1679.7^{a} \pm 107.8$	$2360.7^{b} \pm 109$	$2402.7^{b} \pm 84.8$	$1789.3^{b} \pm 144.5$
Iron	$34.70^{a} \pm 2.52$	$33.73^{a} \pm 4.58$	$32.43^{a} \pm 1.69$	$38.667^{a} \pm 1.52$	$32.50^{a} \pm 1.80$
Copper	$0.62^{a} \pm 0.036$	$0.74^{a} \pm 0.04$	$0.70^{a} \pm 0.04$	$0.73^{a} \pm 0.07$	$0.71^{a} \pm 0.07$

Data presented as mean values for triplicates ± S.D (n=3) a and b letters in same raw are significantly different at (p< 0.05) level; in mg/100g

According to the table 6, the highest sodium content is denoted by Indian 2 with the value of 35.66±1.52 mg /100g and the least value is recorded by the local 1 sample which is 32.00 ± 2.65mg/100g.The highest potassium content is represented by local 2 sample with 2402.7±84.8 mg/100g and the lowest value by the Indian 1 which is about 1603±181 mg/100g.The Indian Types contain a relatively low potassium content than the local types. The fertilizers which are used in the cultivating areas and the soil parameters may be the reasons for this difference. According to USDA, the maximum allowable potassium content is 2525mg/100g.This value is in compliance with the readings of the study. As far as Iron content of Turmeric rhizomes is concerned, highest value is recorded by the local 2 sample and the lowest value by the local 1. According to the table 6, the highest copper content was recorded by the Indian 2 sample and the lowest by the Indian 1 sample.

3.7 Oleoresin content in turmeric rhizomes

Oleoresins are semi solid compounds extracted using alcohol. Since it contained oil and resins it is known as oleoresin. The extracted oleoresin contents of 5 types of turmeric rhizomes are given in the table 7.

Table 7: Oleoresin composition in turmeric rhizomes

Type	Oleoresin composition %
Indian 1	15.29^{a} ±0.06
Indian 2	15.48^{b} ±0.22
Local 1	14.53^{c} ±0.27
Local 2	15.87^{d} ±0.08
Local 3	14.20^{e} ±0.65

Data presented as mean values for triplicates ± S.D (n=3) a, b, c, d, e letters in same column are significantly different at (p< 0.05) level.

According to the data given in the table 7, highest oleoresin composition is given by the sample of local 2, which is around 15.29±0.06% and the lowest value is from the sample of local 3 (14.20±0.65%). Turmeric oleoresin is used for the commercial manufacture of curcumin. So high yield in oleoresin definitely results in high yield in curcumin. Since the sample of local 2 has the highest curcumin content, the oleoresin content too to be the highest. The local 3 sample (Home garden sample) has depicted the highest standard deviation of ± 0.65. This may be due to lack of uniformity in the product. When data is analysed using ANOVA, there is a significant difference among the means of 5 types of turmeric samples (p<0.05).

4. Conclusion

Turmeric is a good source of oleoresins and the genetically modified local variety contains the highest oleoresin content. Indian commercial turmeric types contain a higher amount of oleoresin than the local commercial types. Having a low moisture content in Indian types indicate that they have been dried and processed well than the local types. There is a significant difference in the potassium content among the turmeric types of the 2 countries.

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