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Analysis of curcumin content in Sri Lankan and Indian turmeric rhizomes and investigating its impact on the colour

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Abstract
Curcumin is the main active ingredient in Turmeric and it imparts yellowish colour to the turmeric powder. Since, curcumin content in turmeric differs from type to type, Sri Lankan and Indian turmeric samples were quantitatively analysed using the spectrophotometer and colour measurements were taken in respect to L*a*b* values. A remarkable difference for the curcumin content of both types was observed and which were in the range of 3.76-5.05%. Visual colour difference of five samples of both types was observed and they were in the range from bright to orange yellowish color. A Standard curcumin sample was used to plot the graph for absorbance and it disclose that the samples with a high curcumin percentage appears in bright yellow while the samples with a lower curcumin content imparts a color in orange yellow.

Keywords: turmeric, curcumin, bright yellow, orange yellow

1. Introduction
Curcumin is the main active compound as well as the main colouring agent of turmeric. Curcumin or diferuloylmethane is a yellow polyphenol extracted from the rhizome of turmeric (*Curcuma longa*). Due to the presence of curcumin, turmeric has been used as a coloring agent in India/Sri Lanka throughout centuries. Curcumin is a hydrophobic polyphenolic derivative with both biological and pharmaceutical advantages. It is used as an anti-cancer agent and epidemiological evidence suggesting a correlation between dietary turmeric and low incidence of gastrointestinal mucosal cancers [1]. Chemically, curcumin is a bis-R,-unsaturated -diketone which is commonly called diferuloylmethane. It exhibits keto–enol tautomerism. Curcumin has a predominant keto form in acidic and neutral solutions and stable enol form in alkaline medium. Commercial curcumin contains approximately 77% diferuloylmethane, 17% demethoxycurcumin, and 6% bisdemethoxycurcumin [2]. Curcumin was first isolated in 1815 and its chemical structure was determined in 1973 [3]. Absorptive spectra of curcumin and curcuninoids are very similar, with their maximum values are at 429 and 424 nm, respectively [4]. In addition, curcumin is considered as non-nutritive and non-toxic chemical to mammals even at very high doses (5-10%) by weight of diet [5] the antioxidant activity of curcumin was found with equivalent activity to butylated hydroxyl lanisole (BHA) and butylated hydroxyl ltoluene (BHT) [6]. For example, 40 ppm curcumin could completely prevent aldehyde formation in fermented cucumber tissue that was exposed to oxygen. Like curcumin, demethoxycurcumin and bisdemethoxycurcumin also exhibited antioxidant activity [7]. Recent studies on several animal tumor bioassays have shown that curcumin has a dose-dependent chemopreventive effect against colon, duodenal, stomach, esophageal and oral carcinogenesis [8]. It has been shown that administration of turmeric powder in the diet reduced tumors induced by carcinogenic chemicals such as benzo[α]pyrene (BP) and 7, 12-dimethyl benz [α] anthracene (DMBA). Curcumin can inhibit the growth of estragon positive human breast MCF-7 cells induced individually or by mixture of estrogenic pesticides, such as endosulfane, DDT and chlordane or 17-beta estradiol Alcoholic extracts of turmeric (TE) and turmeric oleoresin (TOR) decreased the number of micronucleated cells both in oral mucosal cells and in circulation lymphocytes [9].

2. Materials and Methodology
2.1 Plant Materials
The Indian commercial samples were collected from Colombo capital market and they were named as Indian I and Indian II. The Sri Lankan samples were collected from three different places namely Spice garden, Export Agricultural Research Institute and a home garden of a regional town & its suburb (Matale) and they were named as Local I, Local II and Local III respectively. The five samples were grinded for 2 minutes until passing through an aperture of 1mm diameter. The samples 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 Determination of the Curcumin Content
According to ASTA method 18.0, 0.1g of turmeric powder was weighed and put into a round bottomed flask. Then 30ml of ethanol was added and the round bottom flask was connected with a refluxing condenser. The reflux was done for two and half hours and the the apparatus was let to cool down.

After that it was filtered into a 100ml volumetric flask and was washed with ethanol up to the mark. Then 2ml was pipette out and put into 25ml volumetric flask. Then the flask was top up with 95% ethanol up to the mark. Finally the absorbance was measured at 425nm (from the spectrophotometer at the Department of soil cultures, Export Agricultural Research Institute -Matale), using alcohol as the blank.

2.3 Determination of the Colour Composition (L*a*b* Values)

According to Bai *et al*., (2013)., Color of the five varieties of turmeric powder samples were determined using a Lovibond R LC Chroma-Meter at the Department of Food Science and Technology, University of Sri Jayewardenepura based on the L* (lightness or brightness), a* (redness/greenness), b* (yellowness/blueness) values, Chroma (C) and hue angle (H_0) .Hue was used as the attribute to determine the color. The reflectance Chroma-Meter was standardized using a white plate; reflectance values of Y= 93.93, x=0.3131, y=0.3189 were used as standards. Turmeric powders of the five varieties were placed in a clean petri dish with 3 cm depth, the measuring head was carried near the surface of the samples and the values for L*, a*, b* were recorded. In order to increase the effectiveness of the results obtained, 10 measurements were taken from each variety at 3 different positions. The equation, [H0 = tan -1 (b*/a*)] was used to calculate the Hue angle (H_0)

3. Results and Discussions

3.1 Quantitative analysis of Curcumin content in turmeric rhizomes of 5 different types

The mean curcumin content and the standard deviation among the 5 different curcumin types are depicted in the table 1.

Table 1: Curcumin content of turmeric rhizomes

Turmeric type	Curcumin content %
Indian I (Pettah)	4.25^{a}±0.12
Indian II (Matale)	4.30^{b}±0.10
Local I (Matale)	3.76^{c}±0.06
Local II (Research Centre)	5.05^{d}±0.08
Local III (Home garden)	3.51^{e}±0.38

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

Statistically analysed data in the table 1 revealed that the sample from research institute (Local II) contains the highest curcumin percentage with 5.05±0.08% and the home garden sample (Local III) contains the lowest curcumin content with 3.51±0.38%. The turmeric varieties which are used for the colouring purposes should contain a high curcumin percentage. So genetical modifications have been done to increase the curcumin yield. Local II is such a genetically modified variety and therefore its curcumin content is comparatively higher. The home garden variety is not grown for the marketing purpose and therefore it has a low curcumin content. The geographical factors of the cultivating regions and the amounts of Nitrogen, Phosphorus and Potassium in the applied fertilizers directly affect the curcumin content of turmeric. Curcumin content can be enhanced by increasing the dosage of potassium [10]. The home garden sample shows the highest standard deviation. Since it is not a market sample, it may not be properly processed as the other samples and all the rhizomes may not be in the same quality. Therefore, there is a considerable difference between the three types of local samples.

3.2 Determination of the colour composition

Table 2: Colour Measurement of different turmeric types

	Indian I	Indian II	Local I	Local II	Local III
L*	47.68^{a}±2.15	46.27^{b}±2.66	36.62^{c}±1.22	54.72^{d}±213	32.63^{e}±1.92
a*	20.90^{a}±1.37	22.06^{b}±1.04	28.36^{c}±1.08	17.48^{d}±0.95	29.12^{e}±1.14
b*	41.24^{a}±0.92	42.04^{b}±0.82	36.06^{c}±1.45	46.06^{d}±2.31	31.46^{e}±1.18

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

According to the data given in table 2, the highest L^* value is for the sample from Research institute Matale (Local II) and the value is $54.72^{\pm 2.13}$. The lowest L* value is for the Home garden sample Matale (Local III) and the value is $32.63^{\pm 1.92}$. Apparently, Research sample is much brighter than the Home garden sample.The visible colour of the Research Sample is bright yellow and the Home garden sample looks in orange yellow colour. It may due to comparatively high curcum in content in Research sample which leads to more bright in yellow colour.

Table 3: Colour Measurements of standard curcumin

L*	a*	b*
64.740±0.372	15.62^{a}±0.33	54.77^{b}±0.39

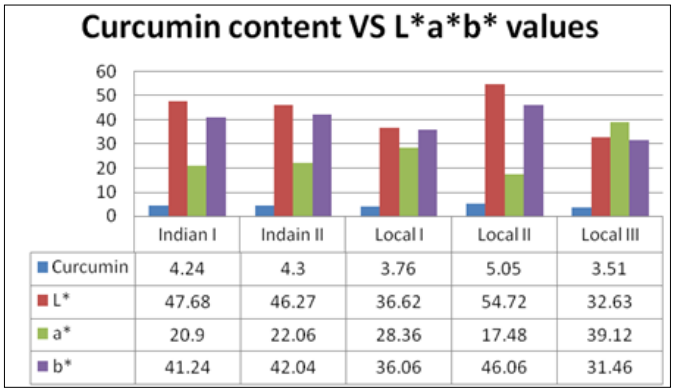
Data presented as mean values for triplicates ± S.D (n=3) and a,b letters in same raw are significantly different at ($p < 0.05$) level.

According to the table 3, L* value is very high in pure curcumin, because pure standard curcumin is a bright yellow colour powder. Further, " a*" value denotes redness and " b*" value denotes yellowness. The values for " a*" is in the range of – 60 to + 60. While, 0 to – 60 representing green colour, red color representing 0 to + 60 in the color scale.

According to the data, pure curcumin has redder colour Intensity than the green colour. The range for "b*" is also from -60 to +60 and – 60 stands for pure blue colour while +60 is for pure yellow colour. Howefer, under this circumstance, curcumin has a very close value to pure yellow colour.

3.3 Relationship between curcumin content and L*a*b* values

Curcumin content in turmeric rhizomes is vastly affecting for the color intensity of the finish product. However, there are other compounds too in the powder which significantly affect vividness of turmeric. Colour meassurments pertaining to the L*a*b* values of turmeric powder are given in the figure 1.



	Indian I	Indain II	Local I	Local II	Local III
Curcumin	4.24	4.3	3.76	5.05	3.51
L*	47.68	46.27	36.62	54.72	32.63
a*	20.9	22.06	28.36	17.48	39.12
b*	41.24	42.04	36.06	46.06	31.46

Fig 1: Curcumin content VS L*a*b* values of turmeric types

According to the bar chart given in figure 1, there is an evident and clear relationship between the curcumin content and the L*a*b* values. When the curcumin content is high, "L*" and "b*" values are also elevating. However, "a*" value is getting low. Since curcumin is a bright yellow coloured compound, the brightness or lightness (L* value) increases when increasing the curcumin content. Sample of the Research Institute Matale contains the highest curcumin percentage of 5.05% and it has the highest L* value of 54.72. The sample of Home garden Matale (Local III) contains the lowest curcumin content of 3.76% and it has the lowest L* and "b*" values of 32.63 and 31.46 respectively. The variation in "a*" value is inversely propotional to curcumin content. There is also a high value for "a*" in the samples with low curcumin content. When the "a*" value is high, it tends towards red colour. Since the "a*" and "b*" values of the sample (Local III) are closely equal, it is equally coordinated with red and yellow colours. As a cumalative effect, the colour of the sample (Local III) is orange which the mixture of red and yellow colours is.

4. Conclusion

Curcumin is a prominent component in turmeric rhizome and its content directly effects on determining the colour of turmeric. The turmeric types with a high curcumin content appears in bright yellow colour while the turmeric with a low curcumin content appears in Orange yellow colour.

References

1. Bisht, Savita. Polymeric nanoparticle-encapsulated curcumin (nanocurcumin): a novel strategy for human cancer therapy. Journal of Nanobiotechnolog. 2007; 5(1):3.
2. Bisht, Savita. Polymeric nanoparticle-encapsulated curcumin (nanocurcumin): a novel strategy for human cancer therapy. Journal of Nanobiotechnology. 2007; 5(1):3.
3. Roughley PJ, Whiting DA. Experiments in the biosynthesis of curcumin. Journal ofthe Chemical Society ---Perkin Transcations I. 1973; 20:2379-2388.
4. Govindarajan VS. Turmeric chemistry, technology, and quality. CRC Critical Reviewsin Food Science and Nutrition. 1980; 12:199-301.
5. Weber WM, Hunsaker LA, Abcouwer SF, Deck LM, Jagt DLV. Anti-oxidant activities of curcumin and related enones. Bioorganic & Medicinal Chemistry. 2005; 13:3811-3820.
6. Sharma OP. Antioxidant activity of curcumin and related compounds, Biochem Pharmacol. 1976; 25(15):1811-1897.
7. Chatterjee S, Desai SRP, Thomas P. Effect of γ-irradiation on antioxidant activity of turmeric extracts. Food Research International. 1999; 32:487-490.
8. Ruby AJ, Kuttan G, Babu KD, Rajasekharan KN, Kuttan R. Anti-tumor and antioxidant activity of natural curcuminoids. Cancer letters. 1995; 94:79-83.
9. Hastak K, Lubri N, Jakhi SD, More C, John A, Ghaisas SD, Bhide SV. Effect of turmeric oil and turmeric oleoresin in cytogenetic damage in patients suffering from oral sub mucous fibrosis. Cancer Letters. 1997; 116:265-269.
10. Akamine H. Effects of application of N, P and K alone or in combination on growth, yield and curcumin content of turmeric (Curcuma longa L.). Plant Production Science, 2007, 10.