International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 437-439

Received: 08-01-2018
Accepted: 09-02-2018

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Studies on chlorophyll content and colour charactristics of lemongrass (*Cymbopogon citratus*) powder

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Abstract
Colour is a visual perception which helps in judging the subjective quality of product. Chlorophyll is a green photosynthetic pigment which helps plants to get energy from light. In present investigation, the effect of traditional (shade and sun) and cabinet drying on chlorophyll content and colour values of fresh lemongrass leaves and its powder were estimated. The fresh lemongrass had 1.7258 mg/g, while shade, sun and cabinet dried lemongrass powder had 0.1994, 0.1567 and 0.1338 mg/g total chlorophyll content. The chlorophyll a was found to be 0.6514 mg/g which was higher than shade (0.1269 mg/g), sun (0.1156 mg/g) and cabinet (0.1006 mg/g) dried lemongrass powder. The chlorophyll b content of fresh leaves, shade, sun and cabinet dried lemongrass powder were 1.0744, 0.0725, 0.0411 and 0.03322 respectively. The carotene content of shade, sun and cabinet dried lemongrass powder were 0.6243, 1.2307 and 1.9366 mg/g which were less compared with fresh leaves (0.7366 mg/g). The colour parameters for L^* values were higher for sun drying (54.81) than shade (52.40) and cabinet (52.33) drying. It was found highest a^* was observed for cabinet (-5.10) followed by sun (-4.49) and shade (-3.45) drying. The highest b^* value was obtained for cabinet (27.82) as compared to sun (26.11) and shade (26.85) dried powder.

Keywords: chlorophyll, carotene, colour values, lemongrass, *Cymbopogon citratus*

Introduction
Chlorophyll is a green photosynthetic pigment which helps plants to get energy from light. The chlorophyll contents were helps to add green colour in final products and also acts as a phytochemical to treat against cardiovascular disease, cancer, skin disease and improves liver detoxification. The primary reason to consider chlorophyll is a superfood due to its strong antioxidant and anticancer effects. Chlorophyll a is bluish-green while chlorophyll b is yellow-green colour pigments. Colour is a visual perception which helps in judging the subjective quality of product. Visual colour perception is influenced by colour sensitivities from person to person, varying environment etc.

Herb is a medicinal plant containing active component to inhibit the growth of microorganism whereby controlling the health complaints. Ayurveda stresses the use of plant-based medicines and treatments (Kukreja *et al*., 2011) [1]. The lemongrass (*Cymbopogon flexuosus* (Steud) Wats) is a perennial grass belonging to family *Graminaceae* and grouped under genus *Cymbopogon*. The lemongrass has a very wide demand in nutritional, medicinal and flavoring industry. But it is not stored as fresh for long time at ambient condition because it rotten after long periods.

Natural antioxidants like phenolic compounds and flavonoids which are secondary plant metabolites present in food products of plant origin (Yeh and Yen, 2003) [2] can trap the free radicals directly or scavenge them through a series of coupled reactions with antioxidant enzymes. They also exhibit a wide range of biological effects, including antiageing, antimutagenicity, and protective effects on oxidative stress (Huang *et al*., 1992) [3]. Natural agents (e.g. plant and/or herbs) possessing antioxidant have the advantage of being readily accepted by consumers (Kingchaiyaphum and Rachtanapun 2012) [4]. Screening of plant extracts revealed that majority of the plant extracts contains phenolic compounds as secondary metabolites.

Hence, the colour values is the way of determining the quality of lemongrass which imparts attractiveness to prepared products. The aim of present study is to analyse the effect of different drying treatments on chlorophyll content and colour values of lemongrass powder. It will beneficial to calculate the colour stability of powder.

Materials and Methodology

The fresh lemongrass leaves were collected from Department of Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Preparation of lemongrass powder

Evenly matured, disease free and sound leaves of lemongrass have to select. The leaves were washed with clean water and subjected to the treatments like cutting, blanching and drying (Lonkar *et al*., 2013) [5]. The lemongrass leaves were dried using three different drying methods such as sun drying for 36 h, shade drying for 48 h and cabinet drying at 45^0C for 7 h (Hanna *et al*., 2012) [6].

Determination of colour values

Colour is the visual property. The colour was determined as per the method with slight modification given by Jambamma *et al*. (2011) [7] using hunter lab Colour flex meter (Model No. ColorFlex EZ) where *L**, *a** and *b** values indicates,

*L**(lightness) axis : Black to white

*a**(red to green) axis : Positive values are red, negative values are green, 0-neutral

*b**(yellow to blue) axis : positive values are yellow, negative values are blue, 0-neutral

C- chroma,

h- hue

Determination of chlorophyll content

1g of leaf sample was weighed and was ground in pestle-mortar with 5 ml distilled water to a paste. The contents were transferred to a centrifuge tube and the total volume was made up to 10 ml with distilled water. 0.5 ml from the tube was transferred to a tube containing 4.5 ml of 80% acetone. The contents were centrifuged at 4000 rpm for 15 min. The absorbance of the supernatant was measured at the following wavelengths 645 and 663 nm (Garg *et al*., 2012) [8].

The optical density was measured and the chlorophyll contents in the original extract was estimated using the formula given by Talreja, (2011) [9],

Total chlorophyll (mg/L) = 20.20 A_{645} + 08.02 A_{663}

Chlorophyll 'a' (mg/L) = 12.70 A_{663} – 02.69 A_{645}

Chlorophyll 'b' (mg/L) = 22.90 A_{645} – 04.68 A_{663}

These can be converted to chlorophyll content in mg/g dry weight as follows:

$$\textbf{Chlorophyll 'a' (mg/g)} = \frac{12.3 \times \text{O.D. at 663 nm} - 0.86 \times \text{O.D. at 645 nm} \times V}{a \times 1000 \times W}$$

$$\textbf{Chlorophyll 'b' (mg/g)} = \frac{19.3 \times \text{O.D. at 645 nm} - 3.6 \times \text{O.D. at 663 nm} \times V}{a \times 1000 \times W}$$

Total Chlorophyll (mg/g) = a + b

Here, O.D. = Optical Density

V = Final volume of chlorophyll extract in 80% acetone

W = Dry weight of plant material

a = the length of light path in the cell (usually 1 cm)

Results and Discussion

Effect of drying on chlorophyll content of lemongrass

Chlorophyll is a green photosynthetic pigment which helps plants to get energy from light. The chlorophyll contents were helps to add green colour in final products and also acts as a phytochemical to treat against cardiovascular disease, cancer, skin disease and improves liver detoxification. The primary reason to consider chlorophyll is a superfood due to its strong antioxidant and anticancer effects. Hence, the effect of drying on chlorophyll contents were necessary to determined. The results obtained were presented in Table 1.

Table 1: Effect of drying on chlorophyll content of lemongrass powder

Drying Method	Total Chlorophyll (mg/g)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Carotene (mg/g)
Fresh	1.7258	0.6514	1.0744	0.7366
Shade	0.1994	0.1269	0.0725	0.6243
Sun	0.1567	0.1156	0.0411	1.2307
Cabinet	0.1338	0.1006	0.03322	1.9366

Chlorophyll is the most indispensable class of primary compounds as they are the only substances that capture sunlight and make it available to plant system for its cultivation on photosynthesis. The Table 1 showed, the total chlorophyll content of fresh lemongrass leaves were higher than the prepared powder. The total chlorophyll content was found in decreased trend with increased drying temperature. The fresh lemongrass had 1.7258 mg/g, while shade, sun and cabinet dried lemongrass powder had 0.1994, 0.1567 and 0.1338 mg/g total chlorophyll content. The results show that drying has a significant impact on chlorophyll degradation; however, the level of its losses is different for each herb species (Śledź and Witrowa-Rajchert, 2012) [10].

The chlorophyll a and b were also decreased with application of drying in case of lemongrass powder. The chlorophyll a was found to be 0.6514 mg/g which was higher than shade (0.1269 mg/g), sun (0.1156 mg/g) and cabinet (0.1006 mg/g) dried lemongrass powder. The chlorophyll b content of fresh leaves, shade, sun and cabinet dried lemongrass powder were 1.0744, 0.0725, 0.0411 and 0.03322 respectively. The carotene is also colour pigment and not stable by application of drying. The fresh lemongrass leaves had highest carotene content i.e. 0.7366 mg/g. The carotene content of shade, sun and cabinet dried lemongrass powder were 0.6243, 1.2307 and 1.9366 mg/g which were less compared with fresh leaves. These variations might be due to the stability of chlorophyll at varying drying conditions.

The obtained results of chlorophyll content of fresh lemongrass leaves were higher than the findings of Garg *et al*., (2012) [8], who observed total chlorophyll, chlorophyll a and b were 0.0031, 0.0039 and 0.0051 g/l in lemongrass leaves respectively. The variation could be attributed to the stage of maturity of the leaves which were harvested for analysis as well as to varietal differences.

Oladele and Aborisade (2009) [11], reported chlorophyll content was highest in fresh leaves and decreased with drying in Indian spinach. The fresh sample had 1.42 mg/100g chlorophyll which was reduced to 1.17, 1.19 and 1.17

mg/100g in sun, shade and oven drying. Hence it could be concluded that maximum retention was observed in shade drying and the powder could be produced with acceptable colour by any of three methods.

Effect of drying on colour values of lemongrass

In some cases, colour changes are accompanied by undesirable changes in texture, taste or odour. These shortcomings can only be solved by using colour instrumentation with internationally specified colour system. The visual assessment of the were quite similar, but the assessment by using colorimeter provided the different results as presented in Table 1.

Table 2: Effect of drying on colour values of lemongrass (*Cymbopogon citratus*)

Sample	L*	a*	b*	Hue	Chroma
Fresh	38.30	-7.22	14.62	116.45	16.48
Sun Drying	54.81	-4.49	26.11	99.76	26.50
Shade Drying	52.40	-3.45	26.85	97.34	27.07
Cabinet Drying	52.33	-5.10	27.82	100.37	28.28

From Table 2, the initial colour of fresh lemongrass for L*, a* and b* was 38.30, -7.22 and 14.62 respectively. The colour parameters for L* values were higher for sun drying (54.81) than shade (52.40) and cabinet (52.33) drying. It indicated that the dried powder was darkening when the time exposure for drying increased and uncontrolled parameters of drying. This might be due to the browning reaction which was accelerated by drying temperature and exposed time.

For a* value, it showed a negative direction. It indicated the greenness of dried powder. It was found highest greenness was observed for cabinet (-5.10) followed by sun (-4.49) and shade (-3.45) drying. The b* indicates the yellow to blue colour. The results showed yellowness of powder. The highest b* value was obtained for cabinet (27.82) as compared to sun (26.11) and shade (26.85) dried powder. The results are comparable with the findings of Sanmeena *et al*. (2012)[12] who studied the change in colour values by varying drying temperature and medium.

The results indicated that the degree of colour change was dependent on drying air temperature. Rudra *et al*. (2008)[13], opined that high temperature could lead to the replacement of magnesium in the chlorophyll by hydrogen, thereby converting chlorophylls to pheophytins. However, the rate of change varied with the temperature. The discoloration of products was more affected by temperature, time and medium of drying. This might be due to pigment degradation during drying process and browning reaction occurring resulting in the colour changes (Asekun *et al*., 2007)[14]. Color changes could be because of chlorophyll pigments were reduced as a result of photooxidation reaction in the cells. In addition, there is competition between peroxidase enzyme and chlorophylase (Vergara-Domínguez *et al*., 2013)[15].

Conclusion

From the present study, it could be concluded that the chlorophyll content was reduced in dried lemongrass while maximum stability obtained in shade drying. The carotene content was increased significantly after drying of leaves and maximum content found in cabinet dried lemongrass powder. The lightness, greenness and blueness were also being increased due to drying treatments, it is varied due to drying temperature and time of exposure. Hence, lemongrass can be preserved in powder form to retain its colour characteristics.

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