

EFFECT OF PROCESSING ON VOLATILE OIL COMPOSITION IN TURMERIC (*CURCUMA LONGA* L.) VARIETIES

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INTRODUCTION

Turmeric (*Curcuma longa* L.) is a rhizomatous perennial crop from the ginger family (Zingiberaceae), commonly known as Curcuma, Curcum, Haridra and Indian saffron (Channappagoudar *et al.*, 2013). Turmeric is a unique ingredient which can be used as a spice, colorant, flavorant and drug. Turmeric owes its aroma to the volatile oil (upto 5%) present in the rhizome, which can be recovered by hydro-distillation process. The major volatile principles of the rhizome oil are α -turmerone (30-32%), β -turmerone (15-18%) and ar-turmerone (17-26%) and minor components are cineole, α -phellandrene, β -caryophyllene and α -zingiberene (Ravindran *et al.*, 2012). The qualitative and quantitative composition of volatile oil varies often with varieties, locations, sources and cultivation conditions (Gupta *et al.*, 2012). Turmeric oil, thus a rich source of phytoconstituents has many applications in cosmetic sector, perfumes and soap industries. It is an antacid and in small doses acts as a carminative, stomachic, appetizer and tonic. Also, they possess anti-inflammatory activities and increases the bile flow. It is also found to be effective against bronchial asthma in clinical trial (Ravindran *et al.*, 2012). Furthermore, exhibits therapeutic properties which are responsible for anti-cancer, anti-oxidant, antimicrobial, antiparasitic, antimutagenic, immunomodulatory, anti-inflammatory, anti-protease and apoptosis inducing properties (Anandraj *et al.*, 2014 and Ravindran *et al.*, 2012).

Literature available (Garg *et al.*, 1999, Lokhande *et al.*, 2013 and Anandraj *et al.*, 2014) on the variation of volatile oil content in fresh, dry and cured forms for the varieties under study are meagre as these varieties are not yet cultivated due to non-availability of plant material for large scale cultivation. Hence, the objective of the present study was to evaluate the variability of volatile oil components of turmeric varieties as affected by processing for a particular season under Agro-climatic zone (dry zone)-5.

MATERIALS AND METHODS

The experiment to study the turmeric volatile oil composition as affected by different processing forms of turmeric rhizomes were carried out at Sanjeevani Vatika, Medicinal & Aromatic Crops section, Department of Horticulture, UAS (B), GKVK, Bengaluru. Eight turmeric cultivars {(Suguna, Sudharshana and Prabha (Short duration), Alleppey supreme, Prathibha, Suvarna and Kedaram (Medium duration) and Local-check (Long duration)} procured from IISR were raised during the month of May, 2013 and harvested in January, 2014, according to the maturity period of the cultivars.

ABSTRACT

In the current study, an attempt is made to understand the variation of volatile principles in eight turmeric cultivars namely, *Local (check)*, *Alleppey supreme*, *Kedaram*, *Prabha*, *Prathibha*, *Suvarna*, *Suguna* and *Sudharshana*. Volatile principles of fresh, dried and cured varieties were quantified through Gas Chromatography (GC). The analysis revealed that Local-check (Long duration crop) in fresh form was found to be statistically superior variety for extraction of sesquiterpenes [ar-turmerone (32.577 ± 0.02) and β -turmerone (19.65 ± 0.015)] which are known to possess pharmacological properties. While, Sudharshana, a short duration cultivar, assures to be a promising cultivar for maximum extraction of monoterpenes [cineole (1.773 ± 0.018) and caryophyllene (2.02 ± 0.006)] in dry form.

KEY WORDS

Curcuma longa
Varietal variation
volatile oil
Turmerone

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Processing of different forms of turmeric rhizomes for volatile oil studies

The harvested rhizomes of all the eight turmeric cultivars were processed as per the standard protocol (Vasundhara *et al.*, 2014). These rhizomes were sorted into 3 different sets: fresh, dry and cured rhizomes. The first set of fresh rhizomes was manually cleaned, grated and subjected to blend in a laboratory blender (Oster) to obtain a fine paste and this sample is referred as 'fresh rhizome'. The second set of fresh rhizomes was manually cleaned, grated, chopped into thin slices and dried in hot air oven at 40°C for 48 hrs and powdered in a laboratory blender (Oster) and this sample is referred to as 'dried rhizome'. The third set of fresh rhizomes was manually cleaned and was processed in excess of boiling water bath for 45 minutes. Later, excess water was drained out and the soft rhizomes were chopped into thin slices, dried in hot air oven at 40°C for 48 hrs and powdered in a laboratory blender (Oster). This sample is referred to as 'cured rhizome'. All these processed samples (fresh, dry and cured) were stored in refrigerator till further analysis.

Extraction of volatile oil from turmeric rhizomes

The powdered turmeric rhizomes of eight varieties in fresh, dry and cured forms were independently subjected to hydro-distillation in Clevenger's apparatus for 5hrs. 15min. The light yellow colored oil obtained was collected and dried over minimum amount of anhydrous sodium sulphate to remove any traces of water & percentage of oil content was estimated on as % v/w basis. The oil extracted was transferred to GC vials and stored in refrigerator for further Gas Chromatographic analysis (Gounder *et al.*, 2012 and Ravindran *et al.*, 2012).

Quantification of volatile oil by Gas chromatography

The Gas chromatography analysis of volatile oil was carried out at Givudan (India) Private limited, Bangalore. The oil was quantified in Agilent 7890A equipped with HP-5 column (30 m x 320 µm x 0.25 µm) coated with: 5% Phenyl Methyl Siloxane. An FID was used for relative quantification of volatile components. Oven temperature was maintained at 80-280°C with increment of 5°C/min for 10min. Injector and detector temperature was maintained at 300°C (Vasundhara *et al.*, 2014).

Statistical analysis

Analysis of variance of volatile oil composition as affected by different forms of processing were analysed using the SAS

program. The experiment had eight treatments replicated three times and expressed as mean \pm SEM. Duncan's Multiple Range Test (DMRT) was applied to determine the existence of significant difference at $p \leq 0.05$ for absolute quantities of each chemical component in the volatile oil for different forms.

RESULTS AND DISCUSSION

The results of the study on Volatile oil composition as affected by different forms of processing in turmeric cultivars are presented and discussed here. Volatile oil was extracted through hydro-distillation in Clevenger's apparatus and was quantified by Gas Chromatography. This study was aimed to select the turmeric cultivar with maximum content of active ingredient and also processing method with maximum quantity of key molecules.

In the present study, the data on essential oil (%) in turmeric varieties as affected by processing methods are presented in Table 1. The statistical analysis revealed that all the turmeric varieties were found to be non-significant for the volatile oil content in fresh, dry and cured forms.

Turmeric in fresh form recorded least oil content in the range of 0.75 ± 0.25 to 1.50 ± 0.5 in all the varieties as compared to dry and cured forms. The lesser oil content recorded may be due to higher moisture content (up to 80%) and least stress factor (Garg *et al.*, 1999). Similar results were reported by (Pruthi, 1998 and Li *et al.*, 2011). Whereas, the dried form recorded maximum oil content in the range of 2.40 ± 0.8 to 4.10 ± 1.1 . This is in confirmation with (Pruthi, 1998), who reported that dried rhizomes recorded 5-6% of volatile oil. The results further suggested that the method of drying seemed to have a significant effect on the quality and quantity of volatile oil (Gounder *et al.*, 2012). Artificial drying (max temperature of 60°C) as carried out in the present study gave a brighter and satisfactory product than sun drying and also recorded higher oil content (Anon, 1995 and Ravindran *et al.*, 2012). The cured rhizomes recorded oil content in the range of 1.60 ± 0.4 to 4.05 ± 0.45 . Similar results were reported (Parthasarthy *et al.*, 2008). However, as compared to dried form; the cured form seemed to have recorded lesser output of oil. This may be due to the leaching of essential oil into the boiling water or could be a possibility of losing the oil constituents of low temperature stability (Athmaselvi *et al.*, 2002). Also, the stage at which boiling is stopped largely influences colour and aroma

Table 1: Essential oil (%) in Turmeric varieties as affected by different forms of processing

Treatments Turmeric varieties	Forms of Rhizome processing		
	Fresh	Dry	Cured
Local Variety	0.95 \pm 0.05	3.05 \pm 0.05	2.25 \pm 0.25
Alleppey supreme	1.15 \pm 0.05	3.40 \pm 0.40	2.50 \pm 0.50
Kedaram	0.90 \pm 0.20	2.40 \pm 0.40	1.60 \pm 0.40
Prabha	0.75 \pm 0.25	2.40 \pm 0.80	2.20 \pm 0.60
Prathibha	0.95 \pm 0.15	2.98 \pm 0.60	2.50 \pm 0.70
Suvarna	1.05 \pm 0.05	3.20 \pm 0.03	2.20 \pm 0.80
Suguna	1.50 \pm 0.50	3.75 \pm 0.25	1.95 \pm 0.05
Sudharshana	1.10 \pm 0.10	4.10 \pm 1.10	4.05 \pm 0.45
Treatment MSS	0.099-NS	0.7096-NS	1.053-NS
Replication MSS	0.1806	1.322	1.051

[Values are Mean \pm SEM of three independent experiments. Data points were Non-Significant (NS) at $p \leq 0.05$ according to DMRT]

Table 2: Chemical composition of volatile's in fresh form of rhizome of eight turmeric cultivars

Treatments Turmeric varieties	Chemical composition of volatiles in fresh form of Rhizome			Rank order	Cineole	Caryophyllene	Rank order
	ar-turmerone	̑-turmerone	̑-turmerone				
Local Variety	32.577 ^a ± 0.02	23.37 ^e ± 0.015	19.65 ^a ± 0.015	1 st	0.7 ^b ± 0.015	0.403 ^d ± 0.015	2 nd
Alleppey supreme	13.347 ^g ± 0.015	23.07 ^f ± 0.015	10.603 ^f ± 0.013	7 th	0.7 ^b ± 0.006	1.007 ^b ± 0.018	1 st
Kedaram	27.083 ^e ± 0.06	27.24 ^c ± 0.015	16.023 ^e ± 0.012	6 th	0.41 ^d ± 0.015	1.503 ^a ± 0.019	1 st
Prabha	31.17 ^b ± 0.015	22.91 ^g ± 0.015	17.95 ^b ± 0.015	4 th	0.567 ^c ± 0.009	0.243 ^e ± 0.009	3 rd
Prathibha	21.65 ^f ± 0.015	32.49 ^a ± 0.015	17.57 ^c ± 0.015	3 rd	0.70 ^b ± 0.012	0.183 ^f ± 0.009	3 rd
Suvarna	29.52 ^c ± 0.015	27.48 ^b ± 0.015	17.57 ^c ± 0.02	2 nd	0.4 ^d ± 0.021	0.257 ^e ± 0.018	4 th
Suguna	27.84 ^d ± 0.015	23.65 ^d ± 0.015	16.13 ^d ± 0.015	5 th	0.53 ^c ± 0.015	0.797 ^c ± 0.018	2 nd
Sudharshana	8.29 ^h ± 0.015	14.51 ^h ± 0.015	6.137 ^g ± 0.009	8 th	0.797 ^a ± 0.022	0.763 ^c ± 0.018	1 st
Treatment MSS	233.77**	79.88**	61.463**		0.0632**	0.637**	
Replication MSS	0.0053	0.0038	0.0018		0.00107917	0.00020417	

[Values are mean ± SEM of three independent experiments. Data points with different superscript within the same rows differ significantly at p≤0.05 according to DMRT]

of final product (Gounder *et al.*, 2012).

Quantification of volatile principles of turmeric varieties as affected by different forms of processing

The quantification of volatile principles (GC analysis) of turmeric varieties as affected by different forms of processing is presented in Fig. 1. Gas Chromatographic analysis of fresh, dry and cured turmeric accounted ar-turmerone, ̑-turmerone and ̑-turmerone as the three major sesquiterpenes. In addition, monoterpenes, cineole and caryophyllene which are present in minor quantities were also reflected.

Chemical composition of volatiles in fresh form of rhizome

The data on chemical composition of volatiles in fresh form of eight turmeric varieties is given in Table 2. The data revealed that in fresh form the content of major sesquiterpene, ar-turmerone varied significantly from 8.29 ± 0.015 to 32.58 ± 0.22. ̑-turmerone varied significantly from 14.51 ± 0.015 to 32.49 ± 0.015. ̑-turmerone significantly varied from 6.14 ± 0.009 to 19.65 ± 0.015. The amount of monoterpene, cineole was in the range of 0.41 ± 0.021 to 0.80 ± 0.022 and caryophyllene in 0.18 ± 0.009 to 1.50 ± 0.019. Among the turmeric varieties, local-check (Long duration crop) in fresh form was found to be statistically superior variety for extraction of sesquiterpenes (ar-turmerone and ̑-turmerone) (Fig. 2). Furthermore, these sesquiterpenes account for more than 50% of total volatile principles and are also known for their pharmacological activities (Singh *et al.*, 2010, Gounder *et al.*, 2012 and Parthasarthy *et al.*, 2008). Additionally, ar-turmerone has been reported as the major aroma principle of turmeric oil which imparts aromatic and spicy fragrance to the fresh rhizome (Parthasarthy *et al.*, 2008 and Singh *et al.*, 2011). Also, this component might increase the medicinal value of the turmeric oil as reported by (Singh *et al.*, 2011). The reason may be attributed to higher boiling point (325-326°C) compared to the other components viz., ̑ and ̑-turmerone. Also, it is the most stable component with higher number of double bonds (5), which is responsible for pharmacological benefits of turmeric (Ravindran *et al.*, 2012). Fresh form of local cultivar can thus be considered as a valuable source of volatile principles, suggesting its domestication and adaptability over a very long period of cultivation. Also, Prathibha variety is a good source of ̑-turmerone in fresh form.

Chemical composition of volatiles in Dry form of Rhizome

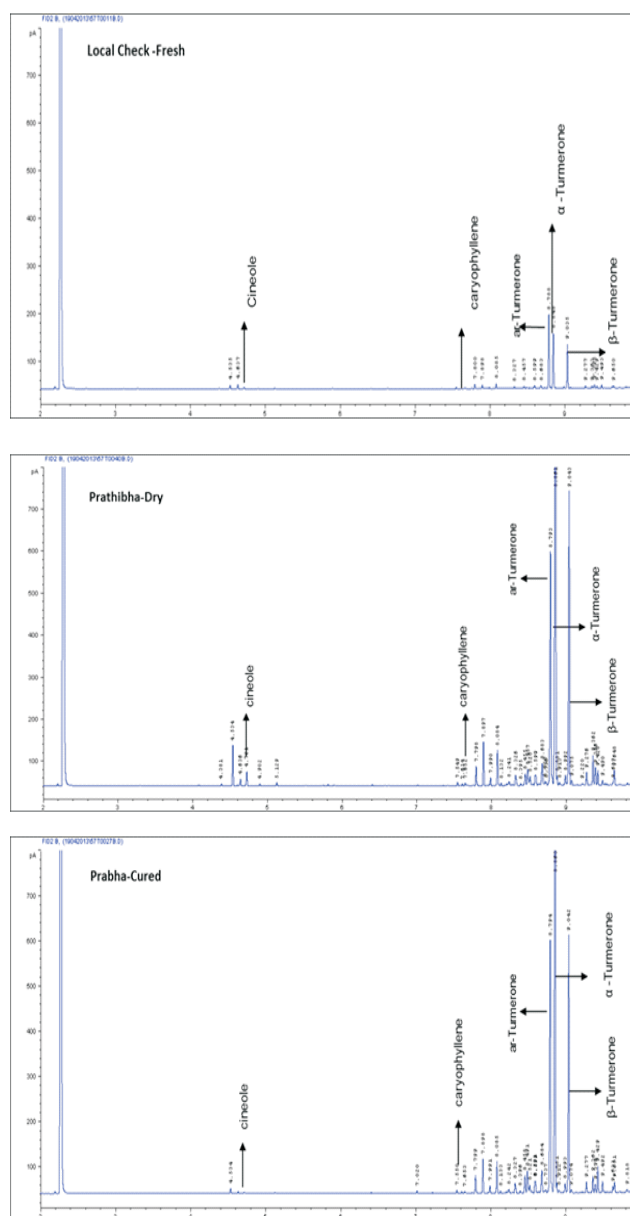


Figure 1: GC Chromatographic profile of turmeric volatile oil (Local check-Fresh; Prathibha-Dry; Prabha-Cured)

Table 3: Chemical composition of volatile's in Dry form of rhizome of eight turmeric cultivars

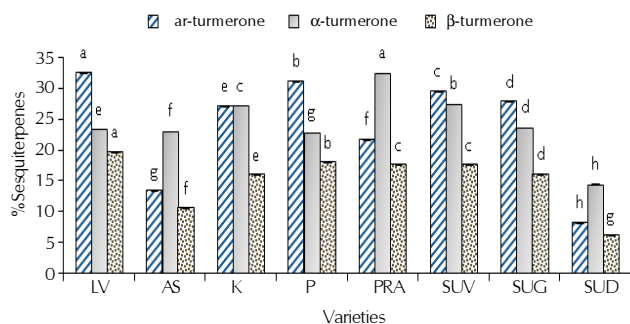
Treatments Turmeric varieties	Chemical composition of volatiles in Dry form of Rhizome			Rank order	Cineole	Caryophyllene	Rank order
	ar-turmerone	̑-turmerone	̑-turmerone				
Local Variety	14.273 ^d ± 0.018	39.77 ^d ± 0.025	17.433 ^d ± 0.018	3 rd	1.187 ^b ± 0.012	0.603 ^d ± 0.018	3 rd
Alleppey supreme	10.083 ^g ± 0.012	26.123 ^f ± 0.012	9.403 ^g ± 0.009	6 th	1.123 ^c ± 0.015	1.827 ^b ± 0.012	2 nd
Kedaram	15.11 ^c ± 0.026	38.353 ^e ± 0.007	15.093 ^e ± 0.007	4 th	0.95 ^d ± 0.026	1.313 ^c ± 0.009	4 th
Prabha	32.203 ^a ± 0.012	16.897 ^g ± 0.019	13.173 ^f ± 0.018	5 th	0.403 ^f ± 0.015	0.28 ^e ± 0.006	5 th
Prathibha	16.283 ^b ± 0.012	40.183 ^c ± 0.012	18.023 ^b ± 0.012	1 st	0.8 ^e ± 0.015	0.183 ^f ± 0.009	5 th
Suvarna	11.263 ^e ± 0.003	46.773 ^a ± 0.018	17.657 ^c ± 0.012	2 nd	0.327 ^g ± 0.012	0.273 ^e ± 0.009	6 th
Suguna	10.963 ^f ± 0.012	45.253 ^b ± 0.018	18.283 ^a ± 0.012	2 nd	0.273 ^h ± 0.012	0.297 ^e ± 0.009	7 th
Sudharshana	1.443 ^g ± 0.012	2.99 ^h ± 0.021	1.083 ^h ± 0.012	7 th	1.773 ^a ± 0.018	2.02 ^a ± 0.006	1 st
Treatment MSS	226.1**	713.922**	106.76**		0.7966**	1.717**	
Replication MSS	0.001	0.0022	0.00065		0.0002917	0.00021667	

[Values are Mean ± SEM of three independent experiments. Data points with different superscript within the same rows differ significantly at pd<0.05 according to DMRT]

Table 4: Chemical composition of volatile's in Cured form of rhizome of eight turmeric cultivars

Treatments Turmeric varieties	Chemical composition of volatiles in Cured form of Rhizome			Rank order	Cineole	Caryophyllene	Rank order
	ar-turmerone	̑-turmerone	̑-turmerone				
Local Variety	15.96 ^c ± 0.015	41.3 ^a ± 0.015	16.43 ^d ± 0.015	3 rd	0.267 ^c ± 0.012	0.48 ^e ± 0.015	3 rd
Alleppey supreme	13.17 ^e ± 0.015	28.713 ^f ± 0.012	12.923 ^f ± 0.012	5 th	0.103 ^e ± 0.012	0.947 ^b ± 0.018	2 nd
Kedaram	16.31 ^b ± 0.015	38.567 ^c ± 0.009	17.563 ^b ± 0.012	2 nd	0.087 ^e ± 0.007	0.637 ^d ± 0.015	4 th
Prabha	19.09 ^a ± 0.015	37.42 ^d ± 0.015	17.75 ^a ± 0.015	1 st	0.09 ^e ± 0.006	0.223 ^g ± 0.012	6 th
Prathibha	15.91 ^d ± 0.015	41.28 ^a ± 0.015	17.01 ^c ± 0.006	3 rd	0.457 ^a ± 0.019	0.257 ^g ± 0.012	3 rd
Suvarna	11.06 ^g ± 0.015	40.23 ^b ± 0.015	15.037 ^e ± 0.012	4 th	0.2 ^d ± 0.006	0.383 ^f ± 0.012	5 th
Suguna	11.44 ^f ± 0.015	35.39 ^e ± 0.015	11.403 ^g ± 0.012	6 th	0.337 ^b ± 0.007	0.813 ^c ± 0.018	1 st
Sudharshana	4.177 ^h ± 0.009	13.69 ^g ± 0.015	3.867 ^h ± 0.007	7 th	0.19 ^d ± 0.01	1.223 ^a ± 0.012	1 st
Treatment MSS	63.48**	264.59**	65.73**		0.05197**	0.3742**	
Replication MSS	0.0012	0.00103	0.00015		0.00048750	0.00080417	

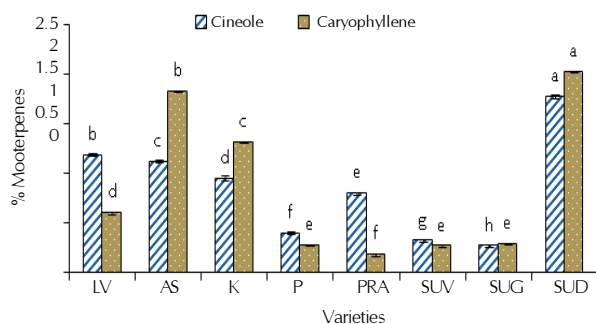
[Values are Mean ± SEM of three independent experiments. Data points with different superscript within the same rows differ significantly at pd<0.05 according to DMRT]



LV: Local-check; AS: Alleppey supreme; K: Kedaram; P: Prabha; PRA: Prathibha; SUV: Suvarna; SUG: Suguna; SUD: Sudharshana

Figure 2: Variation of Sesquiterpene content in Fresh form

The data on chemical composition of volatiles in dry form of eight turmeric varieties is given in Table 3. From the data it was observed that the amount of ar-turmerone varied from 1.44 ± 0.012 to 32.2 ± 0.012 . While α -turmerone content varied from 2.99 ± 0.021 to 46.77 ± 0.018 and β -turmerone varied from 1.08 ± 0.012 to 18.25 ± 0.012 . The amount of monoterpenes, cineole was in the range of 0.27 ± 0.012 to 1.77 ± 0.018 and caryophyllene recorded in the range 0.18 ± 0.009 to 2.03 ± 0.006 in dry form of rhizomes. Also, the present investigation revealed that Prathibha in dry form seemed to be the stable cultivar for extraction of sesquiterpenes. On the other hand the content of α -turmerone was found to



LV: Local-Check; AS: Alleppey Supreme; K: Kedaram; P: Prabha; PRA: Prathibha; SUV: Suvarna; SUG: Suguna; SUD: Sudharshana

Figure 3: Variation of Monoterpenes in Dry form

increase on drying especially with Suvarna cultivar. However, drying had a reducing effect on the content of ar-turmerone. This might be due to greater chance of vapourization of volatile principle during drying (Chassagnez-Mendez, 2000). In addition, Sudharshana, a short duration crop recorded significantly higher content of monoterpenes (Fig. 3) and thus can be considered as a suitable source of monoterpenes (cineole and caryophyllene). The reason may be attributed primarily to the maturity of rhizomes, where at early maturities; turmeric oil is majorly composed of monoterpenes. Further, variability of composition may be due to divergence in varieties, locations, sources and cultivation conditions.

Similar observations were made by Gupta *et al.*, 2012.

Chemical composition of volatiles in Cured form of Rhizome

The data on chemical composition of volatiles in Cured form of eight turmeric varieties is given in Table 4. Gas chromatographic analysis of turmeric varieties in cured form revealed that the amount of sesquiterpene, α -turmerone varied from 4.18 ± 0.009 to 19.09 ± 0.015 , α -turmerone varied from 13.69 ± 0.015 to 41.3 ± 0.015 and β -turmerone in the range from 3.87 ± 0.007 to 17.75 ± 0.015 . The amount of monoterpenes, cineole was in the range of 0.09 ± 0.006 to 0.46 ± 0.019 and caryophyllene was in the range of 0.22 ± 0.012 to 1.22 ± 0.012 . Prabha variety seems to be a better and stable cultivar for extraction of sesquiterpene in cured form. Variation in the content of these constituents (α -turmerone, α -turmerone and β -turmerone) makes a huge difference in their commercial and health value. The variation observed may be attributed to the cultivar, environmental, soil conditions and maturation period of the cultivar (Shadap *et al.*, 2013).

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of the Journal **The Bioscan** during the year.

4. **The best paper presentation award** : It is awarded to the scholar whose presentation is the best other than the young scientist category.
5. **The best oration award** : It is awarded to the scholar who delivered invited speech.
6. **The recognition award** : It is awarded to those senior scholars who have contributed to the subject through their continued research .
7. **The environmental awareness award** : It is awarded to those who, apart from their research contribution, have done commendable extension work for environmental betterment.

The number of recipients of award in each category will vary depending upon the recommendation of the panel of judges and the executive committee. The association has the provision to institute awards in the name of persons for whom a with desired sum is donated in consultation with the executive body.

PUBLICATION OF THE ASSOCIATION

In order to provide a platform to a vast group of researchers to express their views and finding of research as well as to promote the attitude of quality research among the scholars of younger generation the association publishes two journals **1. THE BIOSCAN (ISSN:0973-7049)** - an international quarterly journal of Life Science **2. THE ECOSCAN (ISSN: 0974-0376)** -an international biannual journal of Environmental Science. For the benefit of the potential contributors **instructions to authors** is given separately in this journal. However, the details regarding the journal and also the association can be seen on our website www.thebioscan.in.

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