www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 3075-3079

www.thepharmajournal.com
Received: 19-03-2023
Accepted: 26-04-2023

Sachin R Dhage
M.Sc PHM Scholar, Department of Medicinal, Aromatic, Plantation, Spices and Forest Crops. Post Graduate Institute of Post-Harvest Management and Technology. DBSKKV Dapoli, Maharashtra, India

Dr. GD Shirke
Head of Department of Medicinal, Aromatic, Plantation, Spices and Forest Crops. Post Graduate Institute of Post Harvest Management and Technology. DBSKKV Dapoli, Maharashtra, India

Dr. JH Kadam
Associate Professor, of Department of Medicinal, Aromatic, Plantation, Spices and Forest Crops. Post Graduate Institute of Post Harvest Management and Technology, DBSKKV Dapoli, Maharashtra, India

MS Pinjarkar
M.Sc PHM Scholar, Department of Medicinal, Aromatic, Plantation, Spices and Forest Crops. Post Graduate Institute of Post Harvest Management and Technology. DBSKKV Dapoli, Maharashtra, India

Corresponding Author:
Sachin R Dhage
M.Sc PHM Scholar, Department of Medicinal, Aromatic, Plantation, Spices and Forest Crops. Post Graduate Institute of Post-Harvest Management and Technology. DBSKKV Dapoli, Maharashtra, India

Studies in qualitative changes in Surangi (*Mammea suriga*) flowers during storage

Sachin R Dhage, Dr. GD Shirke, Dr. JH Kadam and MS Pinjarkar

Abstract
Surangi (*Mammea suriga* Buch, -Ham. Ex Roxb Kosterm) is one of the important fragrant flowering and aromatic tree species and endemic to evergreen forest of the Western Ghats. The Western Ghats, which is one of the nine biogeographic regions of India, it possesses various types of tropical forest. The standardization of harvesting stage for higher yield of essential oil content and to study the qualitative changes in surangi flowers during storage are the major objectives of research experiment. Physical, chemical and quality parameters were evaluated against three harvesting stages with five days duration of storage using buds and flowers of surangi. The experiment was carried out with three main treatments, and five sub- treatments and their interaction. Weight of buds and flowers was decreases 100 (g) to 87.4 (g) during storage period, moisture percentage was also decreases 26.23 (g) to 20.96 (g) and variation found in three harvesting stages samples recovery of essential oil percentage was decreased 0.78(%) to 0.39(%)during storage period of buds and flowers. After fixing of standardization of suitable harvesting stage for higher yield of essential oil contents. This fresh flowers of surangi correct harvesting stage is very important to get economical returns to the farmers for handsome returns. All the three stages in which bud stage, fully opened flowers stage and naturally dropped flowers stage in which buds and flowers are stored up to five days then we can verify the effect of qualitative changes in flowers and buds as well as to study effect on oil yield recovery.

Keywords: Surangi (*Mammea suriga), Essential oil, Harvesting stages*

Introduction
Many surangi trees found in the Western Ghats have a narrow distribution. Extremely restricted areas have been reported as the type of localities for a number of species of plants, many of which are endangered or rare (Varghese and Balasubramanyan., 1999) [23]. Pascal *et al*., (2004) [17] reported that the diversity in climatic condition of Western Ghats is expressed by a large variety of tree formations and high species richness. The *Mammea* genus is a panatropical genus belonging to *Clusiaceae* family, with about 75 species in the genus, two in the America, two in Africa, about 40 in Madagascar, one in Australia and the rest in India, South East Asia and New Caledonia (Dunthorn., 2004) [6]. *Mammea suriga* (Family-Clusiaceae) is an also endemic tree species confined to Western Ghats of India (Dassapa *et al*., 2001) [5]. *Mammea suriga* Kosterm. is reported as a threatened tree species and also endemic to the Western Ghats (Patwardhan and Vasudeva, 2003) [18]. In Maharashtra, it is naturally found in the southern part of Konkan and mainly utilized for the extraction of essence. Family (Guttiferae) Clusiaceae, is one of the oldest taxa. Primarily, it is a tropical woody family consisting of 40 genera and 1000 species. The trees are small to medium in size evergreen, resiniferous, polygamous and dioecious trees or shrubs with milky, white, greenish or yellow sap and are mostly resinous. Generally, these trees have either oil glands or passages in leaves and other parts of the tree. The leaves of these trees are opposite, decussate, simple, entire, usually coriaceous and sometimes membranous, rarely stipulate. Flowers are regular, white, yellow, pinkish or red, hypogenous, unisexual or polygamous or bisexual. The bracts are many decussate surrounded at the base of flowers. The perianth of the flower is mostly cyclical or spiral and is often decussate (Anon., 2015) [2]. The surangi tree flowers more than 60 to 70 years. Flowers have high quality value in market. To address the growing demand for plant based pharmaceuticals, perfumes, and flavour products. India has a vast and diversified botanicals resources. This tree is one of the important aromatic tree species of Western Ghats, commonly known as Nagasampige or Punnag in Sanskrit, Suragi in Kannada, and Surangi in Marathi. *Mammea suriga* is an evergreen and forest tree grows up to 600 m. It is found in the states of Maharashtra, Karnataka, Tamil Nadu and Kerala.

This tree species is one of the important non-timber forest trees. A large evergreen tree with hard wood. It is cultivated for its sweet scented flowers and handsome foliage (Gunaga *et al*., 2009) [7], in West Bengal, Assam, Orissa and Uttar Pradesh in India. Evergreen trees are 12-18 m tall, glabrous, monoecious; wood hard, red or reddish-gray, smooth; bark rough, milky sap, latex glands scattered; branchlets obscurely 4-angled. Pulp juicy with flavour of rose water (Anon, 1989) [1]. The existence of a diverse environment in our country provides tremendous potential for the growth of medicinal, aromatic, plantation, spices and forest crops throughout the country as a whole and specifically in the Kokan region of Maharashtra. To address the growing need for plant based pharmaceuticles, perfumes and flavoured goods. India has vast and diversified environment in our country. This offers tremendous plants have remerged as a source of medications, fragrences, and cosmetics in recent decades, this may be due to possibly due to the lack of side effects linked with their user friendly goods. Since, time immoral some of the trees have been a key sources of therapeutic agents for the alleviation and healing of human ailments. The flowers of *Mammea suriga* are used for worshiping in temples and for personal adornment (Kubal *et al*., 2013) [9]. Also this surangi flowers are used in Hindu worship (Rao and Pulliah. 2006) [19]. The conservation of this tree is important for flower collector because in some part of Konkan region rural economy totally depends on production of buds and flowers of surangi. About eight hundred large families are connected in the collection and marketing of surangi flowers. After collection of flowers and buds, collector transport local floral market then to urban market. But awareness about this valuable tree species and flowers production is very little among villagers.

Material and Method

Experimental materials and sample preparation

The three harvesting stage sample was taken from campus of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. In month of mid March after harvesting this sample are stored 5 days for further extraction of oil and their studies. The flowers and buds was carefully placed into the extractor to avoid contamination in the final product, since high values finished product demand maximum extraction efficiency and minimum losses during handling (Younis *et al*., 2011) [24].

Experimental Site

The experiment was conducted at Post Graduate Institute of Post Harvest Management and Technology Killa, Roha under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli. Dist. Ratnagiri (M. S.) during summer season of flowering of surangi (February to April) 2021-2022.

Experimental Design and treatments

The experimental data collected on physical parameters of surangi (*Mammea suriga*) flowers and buds such as weight of buds and flowers, number of buds and flowers per 100 gm was used for analysis. Oil recovery and chemical parameters *viz*. moisture (%), colour of flowers and buds, essential oil (%) were represented as mean value. The data collected on qualitative changes in surangi flowers during storage and its chemical qualities were statistically analyzed by the standard procedure given by Panse and Sukhatme (1985) [16] statistical software**.** Using a Factorial completely randomised design (FCRD), a three-factor experiment was set up and replicated four times.

Statistical Analysis

As a part of this experiment, the harvesting stage treatment and storage period was astimated by use of Factorial completely randomized design (FCRD) to improve experimental and statistical accuracy. The observation were recorded in replicates of four and critical difference was calculated to compare the results of analysis of different treatments using mean value. Analysis and interpretation of data was carried out in accordance with Panse and Sukhatme (1985) [16] using factorial completely randomized design and valid conclusions were drawn only on significant differences between treatment mean at 5 percent level of significance.

Result and Discussion

Physical parameter

Weight of buds and flowers /100 gm

A perusal of data regarding weight of buds at harvesting stages of surangi in three different stages of harvesting at bud stage, harvesting at fully opened flowers stage and harvesting at naturally dropped flowers stage was found significant. The weight of the buds was highest (96.0 g) as compared to fully opened harvesting stage flowers (94.1 g) and naturally dropped flowers harvesting stage (89.2 g). The weight of the stored buds were significantly highest at zero day collection stage (100 g) and lowest on fifth day (93.0 g) of buds and flowers storage period. By comparing interaction between flowers stage with storage period, The maximum weight of buds and flowers was noticed initially in all the stages of harvesting which was at par with second day storage of buds (97.0 g) and fully opened flowers (96.4 g). The minimum weight (80.4 g) was recorded in naturally dropped flowers stage on fifth day of storage.

Further, loss of weight in all the three over storage period could also be due to loss of moisture content over storage duration. The harvesting stage and storage period influenced the weight of buds and flowers. In this the moisture content in buds and flowers of surangi and also its phenological and physiological condition of the buds and flowers influenced the weight of the buds. Kumar *et al*. 2013 [10].

Table 1: Effect of harvesting stages and storage period on weight of buds and flowers per 100 (g)

Harvesting stages Storage period	Bud Stage (g) (H1)	Fully open stage(g) (H2)	Naturally dropped stage (g) (H3)
D1 (Day 0)	100.0	100.0	100.0
D2 (Day 1)	97.0	96.4	94.0
D3 (Day 2)	96.0	94.4	87.4
D4 (Day 3)	94.0	91.0	84.4
D5 (Day 4)	93.0	89.0	80.4

Number of buds and flowers /100 gm

In the present study, total three stages of flowers of surangi was considered. Freshly collected buds and flowers from standing trees as well as collected flowers from naturally dropped under the trees was considered. The count of each stage of flowers was made using 100 g samples. Result showed that, among three different stages of harvesting, bud stage counted with the least numbers per 100 g sample (1239), followed by fully opened flowers (2618.5).

However, the count was found to be more (3256) in third

stage of harvesting i.e., naturally dropped flowers. This clearly indicated that naturally dropped flowers weight was less than bud stage. In contrast, individual bud weight of surangi was more, which was followed by freshly collected flowers and it was least in fallen flowers, collected from the ground under the tree canopy. The physical properties, weight loss, quantity, moisture percent and freshness of buds and flowers throughout the storage period observed in 15 days, finding recorded of tuberose flowers and buds. Madaiah and Reddy, (1994) [13], similar result was observed by Madaiah and Reddy (1992) [12], Nagaraja *et al*. (1999b) [14] and in jasmine Nirmala and Reddy, (1993) [15], Thamaraiselvi *et al*. (2011) [22].

Table 2: Effect of harvesting stages and storage period on No. of buds and flowers per 100 (g)

Harvesting Stages Storage period	Bud Stage (H1)	Fully open stage (H2)	Naturally dropped stage (H3)
D1 (Day 0)	1239.0	2618.5	3256.0
D2 (Day 1)	1252.5	2639.2	3270.7
D3 (Day 2)	1267.2	2661.5	3295.7
D4 (Day 3)	1300.2	2676.5	3312.0
D5 (Day 4)	1312.0	2686.2	3324.0

Chemical parameter

Moisture content (%)

The data reveals that the lowest (12.56) moisture percentage was recorded in bud stage; whereas highest moisture percentage (32.27) was recorded in fully opened flowers stage (H2). Both the stages were statistically significant. The moisture content decreases as the storage period increases. The highest moisture percentage (26.23) was recorded at zero days storage period and lowest moisture percentage (20.96) was recorded, at fifth days storage period.

Considering interaction between harvesting stages and storage period, the overall result showed that, the moisture content of fully opened flowers (H2) was found to be highest in all the storage periods, followed by naturally dropped (H3) from D1 to D5. However, it was the least in bud stage (H1) across storage periods (D1-D5). As storage days increases, the moisture content of flower buds and flowers (H1-H3) decreases in all the three harvesting stages (Table 4.3 and Fig 4.3). considering interaction effect, the highest moisture content (34.27) was recorded in H2 D1 and the lowest moisture content (10.10 %) was recorded in H1 D5 and the result was statistically significant among 15 different treatments (H1D1 to H3D5).

The moisture content found higher in harvesting at bud stage samples and found lowest in naturally dropped flowers stage samples. The moisture content in buds and flowers storage losses as the increase in the period of storage. The dryness of the buds and flowers increases as the moisture content reduced. The effect of the storage period on freshness of lavender buds and flowers and moisture percentage was reduced was found at constant temperature 70 ^{0} C Kotoky *et al*. (2015) [11].

Table 3: Effect of harvesting stages and storage period of buds and flowers of surangi on Moisture content (%)

Harvesting stages Storage period	Bud Stage (H1)	Fully open stage (H2)	Naturally dropped stage (H3)
D1 (Day 0)	14.22	34.27	30.20
D2 (Day 1)	13.17	33.62	28.70
D3 (Day 2)	13.00	31.77	27.47
D4 (Day 3)	12.30	31.22	25.37
D5 (Day 4)	10.10	30.47	22.32

Lightness colour L* value of buds and flowers of surangi

Data on lightness of colour shows that there were significant influence of harvesting stages (H1 to H3), storage days (D1 to D5) and interaction between H and D on lightness of colour of surangi buds/flowers. Lightness of colour significantly varied from 21.9 (H2 stage) to 69.0 (H3 stage); whereas in storage period, it ranged from 37.4 (D5) to 62.7 (D1). Interestingly, the reduction of lightness of colour of buds/flowers of surangi was observed from D1 to D5.

Interaction result showed that the lowest lightness of colour (4.5) was recorded in H2 D5 and highest lightness of colour (78.5) was recorded in H1 D1. The L* value for colour was lowest in fully opened flowers harvesting stage and highest in naturally dropped flowers harvesting stage. The L* value for colour of buds and flowers continuously decreases with increase in the period of storage. Thus, it can be concluded that the lightness of colour of surangi buds and flowers decrease with increase in storage period. Similar observation was reported in the species of orchid fresh flowers and dried flowers. Salma (2010) [20] and Bhupender (2012) [4]. Similar observations was recorded in marigold flowers by Siriamornpun *et al*. (2012) [21].

Table 4: Effect of harvesting stages and storage period on Colour L* value of buds and flowers

Harvesting stages Storage period	Bud Stage (H1)	Fully open stage (H2)	Naturally dropped stage (H3)
D1 (Day 0)	78.5	33.2	76.4
D2 (Day 1)	69.4	28.4	72.5
D3 (Day 2)	54.4	23.7	68.9
D4 (Day 3)	51.3	19.5	68.9
D5 (Day 4)	49.4	4.5	58.3

Redness colour value of buds/flowers of surangi

Data on redness of colour shows that there were influence of harvesting stages (H1 to H3), five days of storage (D1 to D5) and their interaction between H and D on redness of colour of surangi buds/flowers presented. Redness colour of surangi flowers at different harvesting stages was non-significant. The value of redness colour of buds/flowers of surangi ranged from 24.3 (H2 D5) to 2.6 (H1 D1). Interestingly, the increases of redness of colour of buds/flowers of surangi was observed from D1 to D5.

Interaction result showed that the lowest redness of colour (2.6) was recorded in H1 D1 and highest redness of colour (21.7) was recorded in H3 D5. The a* value for colour was lowest in buds harvesting stage samples and highest in fully opened flowers harvesting stage samples. Colour co-ordinates in which darkness of stored surangi buds and flowers increased. The a* value for colour of surangi buds and flowers continuously increases with increase in the period of storage. Similar observations was recorded in the species of orchid fresh flowers and dried flowers. Salma 2010 and Bhupender (2012) [20]. Siriamornpun *et al*. (2012) [21] reported that the darkness of colour of marigold flowers increases continuously during the various storage period.

Table 5: Effect of harvesting stages and storage period on Colour a* value of buds and flowers

Harvesting stages Storage period	Bud Stage (H1)	Fully open stage (H2)	Naturally dropped stage (H3)
D1 (Day 0)	2.6	14.5	10.5
D2 (Day 1)	7.4	18.6	13.5
D3 (Day 2)	10.5	19.3	17.5
D4 (Day 3)	13.5	20.4	19.5
D5 (Day 4)	15.6	24.3	21.7

Yellowness colour value of buds/flowers of surangi

Data on yellowness of colour shows that there were significant influence of harvesting stages (H1 to H3), storage days (D1 to D5) and interaction between H and D on yellowness of colour of surangi buds/flowers.

Yellowness of colour significantly varied from 18.5 (H2 stage) to 35.7 (H3 stage); whereas in storage period, it ranged from 19.9 (D5) to 38.8 (D1). Interestingly, the reduction of yellowness of colour of buds/flowers of surangi was observed from D1 to D5.

Interaction result showed that the lowest yellowness of colour (6.6) was recorded in H2 D5 and highest yellowness of colour (47.5) was recorded in H1 D1. The b* value for colour was lowest in fully opened flowers harvesting stage and highest in naturally dropped flowers harvesting stage samples. The b* value for colour of surangi buds and flowers continuously decreases with increase the period of storage days. Similar observation were recorded in the species of orchid fresh flowers and dried flowers product. Salma 2010 and Bhupender (2012) [20]. It may be due to degradation of chlorophyll content in buds and flowers and some environmental factors can influence the rate of colour variation.

Table 6: Effect of harvesting stages and storage period on of buds and flowers on yellowness colour value

Harvesting stages Storage period	Bud Stage (H1)	Fully open stage (H2)	Naturally dropped stage (H3)
D1 (Day 0)	47.5	29.5	39.4
D2 (Day 1)	43.5	27.4	38.5
D3 (Day 2)	33.5	16.7	36.4
D4 (Day 3)	23.5	12.5	33.4
D5 (Day 4)	22.4	6.6	30.6

Essential oil content (%)

Data on essential oil content (%) shows that there were significant influence of harvesting stages (H1 to H3), storage days (D1 to D5) and interaction between H and D on essential oil content of surangi buds/flowers. Essential oil content significantly varied from 0.37 (H1 stage) to 0.86 (H2 stage); whereas in storage period, it ranged from 0.78 (D1) to 0.39 (D5). Interestingly, the reduction of essential oil content from buds/flowers of surangi was observed from D1 to D5.

Interaction result showed that the lowest essential oil content (0.17) was recorded in H1 D5 and highest essential oil content (1.07) was recorded in H2 D1.

The highest essential oil percentage found in fully opened flowers stage samples as compared to the buds and naturally dropped flowers stage samples. Due to the higher moisture content in fully opened flowers, it has influenced on essential oil content of the flowers. Losses on the moisture content in naturally dropped flowers reduces the essential oil content. As per the increasing dryness of the flower and bud decrease the oil contents So, the first days of harvesting of the buds and flowers of the surangi flowers are important. The similar study was done by Befa *et al*., (2021) [3] on *Rue ruta chalepensis* plant material the highest and lowest value of essential oil content in volume by weight in percentage as 0.673 and 0.174 at 0 days and 10 days respectively.

Hyeon *et al*., (2022) [8] was reported that various stages of harvesting of *Magnolia heptapeta* and *Magnolia denudata* var. purpurascens flowers in which fully developed buds and open flowers are important for extraction of maximum essential oil.

Table 7: Effect of harvesting stages and storage period of buds and flower on essential oil (%)

Harvesting stages Storage Period	Bud Stage (H1)	Fully open stage (H2)	Naturally dropped stage (H3)
D1 (Day 0)	0.55	1.07	0.72
D2 (Day 1)	0.47	0.97	0.67
D3 (Day 2)	0.37	0.80	0.55
D4 (Day 3)	0.27	0.72	0.47
D5 (Day 4)	0.17	0.67	0.32

Conclusion

The aforementioned results revealed following conclusion:

- From overall observations the fully developed opened flowers harvesting stage was found to be the best for higher essential oil recovery and the effect of five days storage period of buds and flowers was acceptable for the study of different qualitative changes. The five days storage period was sufficient for studies of qualitative changes.
- The moisture percentage and essential oil percentage decreases with the increase of storage period.
- The colour (L* a* b*) value of buds and flowers lightness and yellowness decreases and redness, darkness increases during the storage period.

References

1. Anonymous. The Wealth of India: A Directory of Indian Raw Materials and Industrial Products. Publications and Information directorate, CSIR, New Delhi. (M-series). 1989;VI:252-253.
2. Anonymous. *Mammea suriga* – eflora of India. Database of Plants of Indian Subcontinent-developed by the members of Efloraofindia Google Group. 2015. https://efloraofindia.com/ mammea suriga.
3. Befa A, Fikadu D, Mieso B, Mamud A. Effect of drying methods and storage days on essential oil yield and quality of Rue (*Ruta chalepensis*) leaves. Journal Nutrition and food processing. 2021;4(3):1-4.
4. Bhupendar O. Consumer acceptability and keeping quality of dried flowers products using selected packaging material (Doctoral dissertation, Acharya N. G. Ranga Agricultural University). 2012.
5. Dasappa Jagat R, Swaminath M. *Suriga* "Hot Spot" *Mammea suriga* (Buch, - Ham, ex Roxb Kosterm). remains of an evergreen forest in Uttara Kannada district, Karnataka. 2001;2(37):491-494.
6. Dunthorn M. Cryptic dioecy in *Mammea* (Clusiaceae). Plant Syst. Evol. 2004;(249):191-196.
7. Gunaga RP, Vasudeva R. Seed traits and Half-sib family variation for seed germination and early seedling vigour in surangi (*Mammea suriga* Buch.-Ham.Ex Roxb), an important aromatic tree species of the Western Ghats. Journal. 2009;4(16):285-290.
8. Hyeon H, Hyun HB, Boram G, Kim SC, Jung YH, Ham YM. Profiles of essential oils and correlations with phenolic acids and primary metabolites in flower buds of *Magnolia heptapeta* and *Magnolia denudata* var. *purpurascens*. Molecule. 2022;27:221. https://doi.org/ 10.3390/molecules27010221.
9. Kubal SS, Shirke VS, Shirke KK, Wange SS, Gunaga RP, Rane AD. Triple seeds in *Mammea suriga* (Buch.-Ham. Ex Roxb.), an Avenue tree. Research and reviews: Journal of Botanical Sciences. 2013;2(1):1-2.
10. Kumar R, Sharma S, Sood S, Agnihotri VK, Singh B. Effect of diurnal variability and storage conditions on essential oil content and quality of damsack rose flowers (*Rosa damascena* Mill.) in north weastern Himalayas. Scientia Horticulturae journal homepage. 2013;154:102-108.
11. Kotoky R, Rabha A, Gogoi A, Chandranath S, Saikia SP. Correlation studies in seed traits, moisture and oil content and effect of hormones on flowering of *Jatropha curcas* L. Brazilian journal of biological sciences. 2015;2(3):79-84.
12. Madaiah D, Reddy TV. Influence of polyethylene packaging and cool chamber storage on the post-harvest life of tuberose (cv. Single) florets. Karnataka Journal of Agricultural Science; c1992. p.140-14.
13. Madaiah D, Reddy TV. Influence of polyethylene packaging on the post harvest life of tuberose (cv. single) florets. Karnataka Journal of Agricultural Science. 1994;7(2):154-157.
14. Nagaraja GS, Gowda N, Farooqi AA. Shelf life of tuberose flowers as influenced by packaging and ventilation. Karnataka Journal of Agricultural Sciences. 1999;12(1/4):239-242.
15. Nirmala S, Reddy TV. Extension of shelf life of *Jasminum multiflorum* through packaging. Journal of Maharashtra Agricultural University. 1993;27:272-276.
16. Panse VS, Sukhatme PV. Statistical methods for agriculture workers, Indian council of Agril, Research, New Delhi; c1985. p. 87-89.
17. Pascal P, Ramesh R, Franceschi D. Wet evergreen forest type of the Southern western ghats, India. Tropical Ecology. 2004;45(2):281-292.
18. Patwardhan Ankur, Vasudeva R. Conservation and Promotion of Endangered Medicinal Plant Species from Western Ghats of India; c2003. p. 201-205.
19. Rao DM, Pullaiah T. Ethanobotanical studies on some rare and endemic floristic elements of eastern ghats-hill ranges of South East Asia, India. Ethanobotanical leaflets. 2007;11:52-70.
20. Salma R. Studies on dehydration of Dendrobium orchid flowers (Doctoral dissertation, University of Agricultural Sciences). 2010.
21. Siriamornpun S, Kaisoon O, Meeso N. Changes in colour antioxidant activity and carotenoids of marigold resulting from different drying process. Journal of functional foods. 2012;4(4):757-766.
22. Thamaraiselvi SP, Jawaharlal M, Rajamani K, Gunaga M. Studies on packaging technology for long term storage of *Jasminum grandiflorum* L. flowers. Advances in plant Sciences. 2011;24(1):223-230.
23. Varghese A, Balasubramanyan K. Structure, composition and diversity of the tropical wet evergreen forest of the Agasthyamalai Region of Kerala, Western Ghats. Journal of South Asian Nat. Hist. 1999;4(1):87-98.
24. Younis A, Mehdi A, Riaz A. Supercritical carbon dioxide extraction and gas chromatography analysis of *Jasminum sambac* essential oil. Journal of botany. 2011;43:163-168.