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Qualitative analysis of Davana (*Artemisia pallens* Wall.) stored in different packaging materials

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Abstract
The Davana (*Artemisia pallens* Wall.) is a member of the Asteraceae family. South India is the commercial home of this valuable aromatic plant from India. The southern regions of Karnataka are the main locations for its cultivation, with smaller amounts being found in Maharashtra, Kerala, Tamil Nadu and Andhra Pradesh. The experiment was carried out to optimize the moisture for packaging and to study qualitative parameters of Davana during storage. It consisted seven different packaging materials like Aluminium foil paper, Paper bag, Cotton cloth bag, Butter paper bag, Shrink packaging, Gunny bag and Control. Davana storage 0, 90, 180 up to 270 days at ambient condition. The samples during storage were analysed for physiological loss in weight, moisture content and qualitative parameter like glycoside, steroids. The research was carried out with optimizing the moisture of Davana by shade drying. It is concluded that the Davana can be stored in butter paper bags till 270 days at ambient condition.

Keywords: *Artemisia pallens* wall., packaging materials, storage periods etc.

Introduction
The *Artemisia pallens* Wall. commonly known as Davana is one of the Important aromatic crop of India. It is commonly referred to as "Sage Brush" or "Worm wood," The genus *Artemisia* (Asteraceae) is a bitter aromatic plant. of all the genus *Artemisia*, there are 400 species that are found in South Africa, South America, and 34 species in India. This species has the name Artemis in honor of the Greek chaste goddess. Volatile oils are found in some of them. It is known that nearly every species contains sesquiterpene lactones (Suresh *et al*. 2011). With a vast range of species in terms of morphology, ecology, and chemistry, *Artemisia* is the largest genus within the Anthemideae tribe. Fewer taxa are distributed in the Southern hemisphere of the globe than in the Northern hemisphere, where the majority of these species are situated. Species in this genus are still used as traditional medicines worldwide for a variety of health-related issues due to its immense therapeutic potential and exceptional natural value. The complexity of morphology within *Artemisia* species has long been a concern for the taxonomy of the species (Hussain, 2020) [13].
A significant perennial fragrant plant, davana (*Artemisia pallens* Wall.) (2n=16) is a member of the Asteraceae family and is highly valued in India for its subtle scent. South India is home to this common aromatic shrub, which is valued for its fragrant fruit. It is planted for its leaves and blooms. Davana springs add a touch of freshness and a rich fruity scent to bouquets and garlands, where it plays a significant role (Balakumbahan *et al*. 2011) [7]. Women frequently use Davana sprigs in floral arrangements to adorn their hair (Gulathi, 1980) [12]. It is a wild plant found in the temperate Himalayas especially in the Nanital Hills, Simla, and Kashmir Valley, on an area of roughly 1000 acres. It is grown commercially in Karnataka, Maharashtra, Kerala, Tamil Nadu, and Andhra Pradesh. There are over 280 species in the genus *Artemisia*, the majority of which are found in temperate climates worldwide (Rao and Randhwa, 1978) [23]. About thirty species of the genus *Artemisia* are found in India, and they are mostly restricted to the Himalayan area, while some species also thrive in tropical and subtropical regions (Bakshi and Kaul, 1984) [6]. With mixed results, attempts have been undertaken to grow this crop in the agroclimatic conditions of North India (Gulathi, 1980) [12].

In terms of davana output and area, Karnataka leads the pack, with Bangalore encompassing the majority of the state.

Davana is a 60 cm tall, aromatic, erect herb with deeply split leaves and tiny yellow blooms. The tomentum is clothed in a grayish-white colour on the stem and leaves. The leaves are lobed, petiolate, and alternating with peduncle to sessile, axillary, or lax raceme-forming flowers that are simple, heterogamous, and feature bisexual disc florets in the center and a few pistillate ray florets on the perimeter, the inflorescence is capitulate. With the exception of a few cottony hairs, the outer florets are glabrous, tubular, and often have three lobes. Usually two lobes, the stigma is seldom three lobes. There are five stamens with free, epipetalous filaments and a dithecous inflorescence. The inner florets are glabrous except for a few cottony hairs, tubular, five-lobed, and bisexual. The syngenecious anthers are connective, extended, tapering style, and bifid (Dongare, 2022).

The crop grows on a variety of soil types, ranging from medium black to sandy loam. The ideal soil, however, is one that is sandy loam, rich in organic matter, and well-drained. Davana works well in soil that has lost nutrients (Aishwath and Rattan, 2016).

A crucial factor to take into account when growing davana for essential oil extraction is the season. Due to its ideal climate, it is only grown in a small area of south India. When the crop was produced in the winter as opposed to other seasons, it was found that the oil content in the plants was at its highest. Therefore, the first week of November is the best time to plant a crop intended for oil production. A few gentle showers combined with mild winter weather and no frost are ideal for the plant's healthy growth (Durgadevi *et al*. 2022) [10].

The hydrocarbons (20 %), esters (65 %), and oxygenated compounds (15 %) are the main constituents of Davana oil. The primary component responsible for Davana's distinctive scent is its esters. 10 % cinnamic acid is produced when the oil is saponified, and viscous oil with a high boiling point is produced by the alcohol component. The oil's distinctive smell is reportedly caused by a novel sesquiterpene ketone known as cis davanone. A unique class of sesquiterpenoids called "davanafurans," another ketone called "isodavanone," and an other sesquiterpene ketone called "artemone" are among the other components identified from the oil. The primary components of davana oil were determined to be cis-davanone (45.8 %), bicyclogermacrene (9.6 %), linalool (2.5 %), caryophyllene oxide (2.2 %), and phytol (2.1 %). The analysis revealed that the primary components of the fraction were (Z)-ethyl cinnamate (5.2 %), davana ether 2° (5.2 %), and cis-davanone (72.2 %) (Bail *et al*. 2008) [5].

The oil is mainly extracted by steam distillation method. Prior to distillation, the gathered material is sun-dried for two days. Distilling this right away is preferable to storing it. High-quality oil is obtained by steam distilling the dried material. However, the shade-dried material is hydro-distilled for the estimate of essential oil under laboratory conditions, especially of a tiny sample. The air-dried herbage is cut into smaller pieces and charged into the still for distillation. It is important to fill the still tightly to prevent the formation of steam channels during the distillation process, which would lead to low yields. It takes about six hours to finish charging. The bottom layer, which is made up of tiny amounts of both water and oil, needs to be clarified once the upper, transparent layer of oil has been decanted. A saturated sodium chloride solution is added to this mixture in order to separate the oil, resulting in the formation of a distinct layer of oil and water. With the aid of a separating funnel, the lower water layer is drained out, and the upper oil layer is collected (Durgadevi *et al*. 2022) [10].

Cultivated commercially for its essential oil, which is mostly used in medicine, culinary flavoring, and perfumery. According to Ramachandriah *et al*. (1987), the leaves and blossoms contain an essential oil that is prized for its delicate and appropriate aroma and is used in high-end cosmetics and perfumes. Davana is believed to smell uniquely on each individual when applied topically. In upscale perfumery, this unusual quality is highly prized for producing scents with distinctly unique notes. In addition to having antihelmintic, antipyretic, and tonic qualities, davana plants make excellent feed. The oil has stimulant, antispasmodic, antibacterial, and antifungal qualities (Suresh, *et al*. 2011) [28]. Davana possess anti-diabetic properties and was used in traditional medicine against diabetic because it is hypoglycaemic, increases peripheral glucose utilization or inhibits glucose reabsorption (Manisha *et al*. 2007) [17]. The essential oil of Davana which is a brown, viscous liquid with a rich, fruity odour has acquired a considerable reputation in the international trade, particularly in USA and Japan where it is being used for flavouring cakes, pastries, tobacco and beverages.

As Davana is mainly cultivated in Rabi season, In the traditional storage its properties and secondary metabolites present in it are lost. This will result into the price loss to the farmers. Hence the present experiment is planned to optimize the moisture for packaging and to study qualitative parameters of Davana during storage**.**

Materials and Methods

The research experiment was conducted during the year 2023-24 at the Department of Post- Harvest Management of Medicinal, Aromatic, Plantation, Spices and Forest Crops (MAPSF), Post Graduate Institute of Post-Harvest Technology and Management Killa-Roha, Dist- Raigad, Maharashtra, India. The material for experiment was collected from local Davana growing farmer vicinity in the nearby area. The *Artemisia pallens* Wall. that were gathered after harvesting were utilised. 100 g *Artemisia pallens* Wall. were individually stored in different packaging materials for storage, which includes Aluminium foil paper, paper bag, cotton bag, butter paper, shrink packaging, gunny bag and control. The experiment was laid down in Factorial Completely randomized Design (FCRD) with two factors and three replications. The first factor comprises of seven packaging materials *viz*., aluminium foil paper, paper bag, cotton cloth bag, butter paper bag, shrink packaging, gunny bags and control while second factor comprises storage periods as initial, 90, 180 and 270 days. Analysis and interpretation of data was carried out in accordance with Panse and Sukhatme (1985) [19] and Amdekar (2014) [3].

Methods adopted

Physical Parameters

Physiological loss in weight (%)

To calculate physiological loss in weight (%) method described by (Sahoo *et al*. 2014) is used. At each point of storage, the weight of each *Artemisia pallens* Wall. package sample was measured using a laboratory weighing balance

with a 0.0001 g precision. The initial weight of the samples was used as the basis for calculating the PLW, which was then represented as a percentage.

PLW (%) = (Initial weight of package − Final weight at each period of storage)/100 × 100

Chemical Parameters

Optimization of moisture

Optimization of moisture content of *Artemisia pallens* Wall. sample was determined by shade drying. The fresh plant materials were kept for shade drying for three days. The final weight of plant was recorded by using the following formula (Ranganna, 1986) [22].

$$\text{Moisture content (\%)} = \frac{\text{Wm} - \text{Wd}}{Wm} \times 100$$

Where,
Wm= initial weight of sample (g)
Wd= weight of dry sample (g).

Moisture (%)

The initial moisture content of the *Artemisia pallens* Wall. was determined by using the hot air oven method. The fresh plant materials were kept in the trays. The trays were kept in a hot air oven at 45±5 °C. The final weight of plant was recorded until constant weight. The moisture content was determined by using the following formula (Ranganna, 1986) [22].

$$\text{Moisture content (\%)} = \frac{\text{Wm} - \text{Wd}}{Wm} \times 100$$

Where,
Wm= initial weight of sample (g)
Wd= weight of dry sample (g).

Qualitative parameters

Preparation of plant extract

Magnetic stirrer method of extraction was carried out to prepare the crude extract of *Artemisia pallens* Wall. Powdered plant material (10 g) was taken in the beaker and extracted with organic solvents (200 ml) such as ethanol, ethyl acetate and petroleum ether. They were left for 48 hrs in the magnetic stirrer. This procedure was repeated four to five times and then the resulting infusion was filtered using a normal filter paper.

Glycoside

Five drops of H_2SO_4 was added to 1 ml of the extract and the mixture heated in boiling water bath for about 15 minutes. 3 ml of Fehling's solution was then added and the mixture boiled. A brick-red precipitate was confirmatory for the presence of glycosides. (Kanimozhi and Balaji, 2018) [15]

Steroid

Five drops of concentrated H_2SO_4 was added to 2 ml of the extract in a test tube. Red colouration was observed which is indicative for the presence of steroids (Kanimozhi and Balaji, 2018) [15]

Results and Discussion

Physical Parameters

Physiological loss in weight (%)

The data on the Physiological loss in weight percent value for *Artemisia pallens* Wall. during storage in different packaging materials are presented in Table no.1. The physiological weight loss was measured in order to calculate the amount of moisture lost by the *Artemisia pallens* Wall. through various packaging materials. The change in PLW (%) of the stored *Artemisia pallens* Wall. was significantly influenced by various packaging materials. The treatment T_4 (8.342 %) was noted significantly lowest mean for PLW followed by T_1 (9.033 %) while the highest mean for PLW was recorded in treatment T_7 (23.825 %). The data showed a rise in PLW (%) *Artemisia pallens* Wall. during storage, which may be due to moisture loss in the surrounding environment i.e., the packaging material. The interaction between different packaging materials with respect to the storage duration was also found to be significant. The significantly lowest physiological loss in weight was noticed in T_4 (17.10 %) while maximum in control (39.167 %) upon 270 days of storge.

Table 1: Effect of different packaging materials and storage period on PLW % of *Artemisia pallens* Wall.

Treatments	PLW %				Mean
	Storage periods				
	0 Day	90 Days	180 Days	270 Days	
T_1	0.000	7.000	11.100	18.033	9.033
T_2	0.000	17.100	23.033	29.100	17.308
T_3	0.000	15.133	21.167	28.000	16.075
T_4	0.000	5.100	11.167	17.100	8.342
T_5	0.000	10.033	14.900	21.000	11.483
T_6	0.000	21.033	30.100	35.000	21.533
T_7	0.000	25.033	31.100	39.167	23.825
Mean	0.000	14.348	20.367	26.771	
		S.Em ±		CD at 5 %	
Treatments (T)		0.030		0.085	
Storage (S)		0.023		0.064	
Interaction (T×S)		0.060		0.170	

Chemical Parameters

Optimization of Moisture: The data on the optimization of moisture of *Artemisia pallens* Wall. Before storage is presented in Table No. 2. The average initial moisture content of *Artemisia pallens* Wall. was 71.2 %. Shade dried material took 3 days to reach a moisture content of 12.10 %.

Table 2: Optimization of moisture before storage of *Artemisia pallens* Wall

Weight of fresh *Artemisia pallens* Wall. (g)	Weight after drying (g)	Total time (hrs)	Initial Moisture %	Final moisture after shade drying
500	144	72	71.2	12.10 %

Moisture (%)

The data on the moisture content for *Artemisia pallens* Wall. during storage in different packaging material are presented in Table No. 3. Moisture content is an indication of changes in the water level present in the *Artemisia pallens* Wall. A low variation in moisture content during storage is desirable for higher drug stability. The effect of different packaging materials has a significant effect on moisture content. The

significantly maximum mean moisture content was in T_4 (11.175 %) followed by T_1 (11.025 %), T_5 (10.933 %), T_3 (10.308 %), T_2 (9.575 %) and T_6 (8.042 %). Minimum mean moisture content was found in T_7 (7.883 %).

The interaction between the packaging materials and the storage duration on the moisture (%) was significant. The lowest initial moisture (12.10 %) observed in T_1, T_3, T_4 and T_6 while it was found to be maximum in T_4 (10.667 %) upon 270 days storage. The significant change in the moisture (%) was noticed during storge. The significantly maximum moisture (12.119 %) was recorded initially which was gradually decreased to (8.538 %) upon 270 days of storage.

Table 3: Effect of different packaging materials and storage period on moisture % of *Artemisia pallens* Wall.

Treatments	Moisture %				Mean
	Storage periods				
	0 Day	90 Days	180 Days	270 Days	
T_1	12.100	10.833	10.700	10.467	11.025
T_2	12.167	9.733	8.533	7.867	9.575
T_3	12.100	10.133	9.733	9.267	10.308
T_4	12.100	11.067	10.867	10.667	11.175
T_5	12.133	10.733	10.533	10.333	10.933
T_6	12.100	7.867	6.467	5.733	8.042
T_7	12.133	7.800	6.167	5.433	7.883
Mean	12.119	9.738	9.000	8.538	
		S.Em ±		CD at 5 %	
Treatments (T)		0.029		0.081	
Storage (S)		0.022		0.061	
Interaction (T×S)		0.057		0.162	

Qualitative parameters
Glycoside and Steroid

Table 4: Effect of different packaging materials and storage period on glycoside and steroid of *Artemisia pallens* Wall.

Parameters	Treatments	Storage periods			
		0 Day	90 Days	180 Days	270 Days
Glycoside	T_1	+	+	–	–
Steroid		+	+	+	+
Glycoside	T_2	+	+	–	–
Steroid		+	+	+	+
Glycoside	T_3	+	+	–	–
Steroid		+	+	+	+
Glycoside	T_4	+	+	–	–
Steroid		+	+	+	+
Glycoside	T_5	+	+	–	–
Steroid		+	+	+	+
Glycoside	T_6	+	+	–	–
Steroid		+	+	–	–
Glycoside	T_7	+	+	–	–
Steroid		+	+	–	–

Presence indicates by '+' and absence indicates by '–'

The qualitative analysis of glycoside in *Artemisia pallens* Wall. during storage in different packaging material are presented in Table 4. The table indicate that the glycoside present in *Artemisia pallens* Wall. is retained at all packaging materials during 0 and 90 days, but degraded in all packaging materials at 180 and 270 days. The steroids were present in *Artemisia pallens* Wall. in T_1, T_2, T_3, T_4 and T_5 upon 270 Days of storage, but in T_6 and T_7 it present only upto 90 days storage period and fully degraded form 180 and 270 days of storage.

Discussion:
Physical parameter
Physiological loss in weight (%)

The treatment T_4 (8.342 %) was noted the lowest mean for PLW while the highest mean for PLW was recorded in treatment T_7 (23.825 %). The data showed a rise in PLW (%) of *Artemisia pallens* Wall., which may be due to moisture loss in the surrounding environment i.e., the packaging material. The interaction between different packaging materials with respect to the storage duration was also found to be significant. The fact that water loss accounts for the majority of the physiological processes may be the cause of the physiological loss in weight. The beneficial effects of butter paper include heat resistant, non sticky adequate ventilation, the production of a modified atmosphere with high humidity and low temperate temperatures, which lowers the concentration of oxygen and, thus, lowers respiration. This is consistent with Suhrita *et al*. (2005) [27] theory that as the substrate for respiration was limited, the concentration of carbon dioxide would increase, reflecting the gladiolus's minimal physiological weight loss. The result are also in line with Pranuthi *et al*. (2018) [20] in carnation.

Chemical parameters
Quantitative parameters
Optimization of moisture

The average initial moisture content of *Artemisia pallens* Wall. was 71.2%. Shade dried material took 3 days to reach a moisture content of 12.10%. Thamkaew *et al*. 2021 reported that the herbs are kept out of direct sunshine, in a room with adequate ventilation, low humidity and shadow. The vented air is heated by solar radiation prior to passing through the herbs during the shade-drying process (Sharma *et al*. 2009) [25]. Because this drying technique can limit light-induced chemical reactions like oxidation and preserve light-sensitive materials, it may be advantageous over sun drying. Comparing shade drying to other drying techniques, studies employing this technique have demonstrated that shade drying preserves the essential oil content and colour of the dried items better. Shade drying also shown good retention of bioactive substances in terms of their content such as misai kucing (*Orthosiphon aristatus*) (Abdullah *et al*. 2012) [1].

Moisture %

The values showed that the ability of the packaging materials to preserve moisture and maintain integrity of the spices. The results observed were in accordance with work done by Packiyasothy *et al*. (1983) [18]. The moisture was observed to decrease with storage period and has a significant effect on the same. The maximum total mean moisture was found in T_2 (12.167 %) which was at par with all treatments at 0 day. Smitha *et al*., (2020) [26] in Kalmegh as well as Babarinde and Fabunmi, (2009) [4] in okra performed the similar line of work.

However, significantly maximum moisture was observed in T_4 at 270 days of storage. The butter paper bags are moisture resistant, heat resistant and low water absorbing capacity due to which it may reduce moisture loss.

Qualitative parameters

Glycoside: Glycosides are important class of secondary metabolite which exhibits numerous important

pharmacological actions. Joseph and Chandran (2020) showed that glycosides were present up to 90 days of storage but at 180 and 270 days glycoside are absent in all packaging materials. The findings showed that the prepared herbal tea's qualitative phytonutrient composition, such as its steroids and glycoside content, decreased with storage time. The supportive result was reported by Lunghar *et al*. (2018) [16] in herbal tea. The hydrolysis and β-elimination is a part of the biological degradation of natural product glycosides (Bitter *et al*. 2023) [8]. The increased in temperature hastened the breakdowned of glycoside. In addition to temperature, other factors that impact glycoside stability include light and pH. In *Osmanthus fragrans* Lour. flowers, exposure to light and higher pH levels accelerated glycoside breakdown (Zhou *et al*. 2017) [30].

Steroid

The results showed that steroid were present at only 90 days of storage in all packaging materials. But at 180 and 270 Storage days steroids were absent in T_6 and T_7 packaging materials. Microbial dioxygenases, which are produced by microorganisms on stored seeds, can cause sterols to oxidise and lose some of their content. Another factor contributing to the breakdown of sterols may be lipid peroxidation brought on by reactive oxygen species inside plant cells, which can impair metabolism and ultimately cause cell death. The seeds go through respiration-related metabolic activities while being stored Gawrysiak-Witulska *et al*. (2020) [11]. The findings showed that the prepared herbal tea's qualitative phytonutrient composition, such as its steroids content, decreased with storage time. The supportive result was reported by Lunghar *et al*. (2018) [16] in herbal tea.

Conclusion

After the optimization of the moisture by shade drying of *Artemisia pallens* Wall. it was stored in different packaging materials. It can be concluded that *Artemisia pallens* Wall. packed in butter paper bag reported slower degradation process, better preservation of the herb properties and extended shelf life. During 270 days of storage period the physical parameters such as physiological loss in weight and chemical parameters such as moisture, glycoside, steroids was better in butter paper bag among all the treatments. Hence it is concluded that the *Artemisia pallens* Wall. can be stored in butter paper bags till 270 days at ambient condition.

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