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On-Farm Value Addition to Henna Leaf for Better Quality and Shelf Life with LPG Dryer (CRIDA dryer)

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ABSTRACT: A study was conducted at CRIDA, Hyderabad to study the effect of different drying and storage methods on quality, color retention and shelf life of henna leaves. Henna leaves were dried by different drying methods viz., open air drying (Sun), shade and LPG based CRIDA dryer at 40, 50 and 60°C. The dried leaves were powdered and stored in high density poly ethylene (HDPE) (40 μ) and brown paper covers. The stored powder was assessed for color and quality at 3 months interval during storage. The leaves dried with CRIDA dryer at 50°C had higher lawsone content and retained better chlorophyll content as compared to other methods of drying. Drying the leaf at 50°C by CRIDA dryer consumed less energy as compared with other drying temperatures (40, 60°C). Further leaf dried at 50°C when stored in plastic cover of 40 μ thickness had better shelf life as it retained more chlorophyll and lawsone contents even after one year of storage.

Key words: CRIDA dryer, lawsone, chlorophyll, shelf life, energy consumption

Natural dyes or colors from plants are used in several industries like pharma, food, textile and cosmetic, which were slowly replaced by synthetic dyes in 19th Century. There exists a plethora of knowledge on the benefits of natural dyes and adverse effects of synthetic dyes. Recently increase in public awareness on the detrimental environmental impact of synthetic dyes, has led to increase in popularity of natural products (Lubbe and Verpoorte, 2011). Among the natural dyes, henna (*Lawsonia inermis)* is an important dye which is used as textile dye for wool and silk (Hakeim *et al*., 2003) and hair dye prior to invention of synthetic dyes (Khemchand *et al*., 2003; Lavhale and Mishra, 2007). The demand for henna dye has increased recently due to realization of toxic effects of synthetic hair and cosmetic dyes. So its cultivation is gaining importance in rainfed regions. India is the largest producer of henna with estimated production of 10.5 tons, of which 70% is being used in India and 30% is exported to Middle East, USA, Turkey and UAE etc (Bechtold and Mussak, 2009; Singh *et al*., 2005).

Henna is mainly cultivated in Punjab, Gujarat, Rajasthan and Madhya Pradesh (Khandelwal, 2002). The cultivation of this crop is a boon to the farmers of the hot and arid rainfed regions, where production of arable crops is constrained by low and erratic rainfall, high evapotranspiration and poor soil physical and fertility conditions, as henna is drought hardy due to deep root system (Rao *et al*., 2002).

The principal coloring chemical in henna is lawsone, a red orange colored molecule (2-hydroxy -1, 4 naptha Quinone) whose concentration ranges from 1-3% in dried leaves (Simon *et al*.,1984). The cultivation of henna is profitable if the product fetches higher price. Furthermore, the price of leaves or powder depends on the leaf quality, which is determined by its color, purity, dyeing property and fineness (BIS, 1985). To maintain the attractive green color, usually traders add synthetic color to the powder. The drying and storage methods influence the lawsone content and color of the leaf. Moreover the color of the dried leaf varies from olive green to brown color (Rao *et al*., 2005). The appropriate drying and storage methods can curtail the post harvest losses of crop to a tune of 30%.

Traditionally henna leaf is dried either by shade or open air drying which involves low capital and operating costs. But, there are certain constraints in drying the leaf with these methods. In shade drying space is a constraint, if cultivated in large area and also laborious since frequent turning of leaf is essential otherwise it results in improper drying and microbial attack which ultimately deteriorates the produce quality. While in open air drying, UV radiation from sun causes serious undesirable quality, color loss and contamination of the produce (Ertekin and yaldiz, 2004) and moreover it is weather dependent. As a result, the final product is of poor quality with low market acceptability and value (Bechoff *et al*., 2009). To overcome such difficulties in drying, solar dryers and cabinet dryers with different sources of energy have been developed. But most of these drying methods are complex and are unaffordable to small and marginal farmers. This necessitated for development of low cost alternative energy based drying methods. A liquid petroleum gas (LPG) fuel based dryer developed at CRIDA for drying fruits, vegetables and medicinal plants was used for the experiment.

Often, the produce does not find immediate market and if the produce is not stored properly deterioration in color and quality is noticed. Hence, it is important to identify and develop a proper drying and storage method to maintain quality of the produce and fetch higher price in the market.

Materials and Methods

Design of CRIDA dryer

The CRIDA dryer with LPG as fuel consisted of a drying chamber of 6 m^3 volume, removable stand to mount trays, furnace with 2 gas burners, 0.5 HP blower to blow hot air, and a thermostat to maintain temperature. An inlet and outlet openings are provided for controlling humidity. The design features and specifications of the dryer are described by Pratibha *et al.* (2010). The study was conducted during December-January 2008, with freshly harvested henna leaf.

Drying methods

Well matured, fresh henna leaves obtained from the henna plantation of Hayathnagar Research Farm (HRF) of CRIDA were dried as per the treatments viz. shade, open air drying and in CRIDA dryer. In open air drying, henna leaf was dried by loading the samples on the concrete platform in open Sun. Using CRIDA dryer, the leaves were dried at 40^o, 50^o and 60^oC. The leaf was spread uniformly on the trays to ensure proper drying. In shade drying, the leaves were dried at room temperature. Drying of the leaves under different treatments was carried until the moisture content of samples was brought to 6%. Another experiment was also conducted to study the influence of humidity on the quality and drying time. Since 50^0C was optimum temperature for drying in herbal dryer, two humidity levels were tested at this temperature. The humidity levels were maintained by opening and closing of the lid at the top of the dryer.

Shelf life of henna

To devise the optimum storage conditions, dried henna leaves from different drying methods were powdered and stored in polythene covers (PC) with 40µ thickness and brown paper covers (BC). Packed samples were stored at room temperature in laboratory at 20 - 25^0C and 30-34% of relative humidity for 12 months. To assess the shelf life, the stored powder was analysed for color and quality at 3 months interval. In another experiment, dried henna leaves were stored in HDPE covers under storage conditions like dark and light. The samples were stored in opaque cover and kept in complete dark condition in a room, where as in light they were placed outside under room temperature conditions.

Quality of leaf

It was assessed by estimating the color of the leaf and drying properties. Lawsone content in fresh and dried leaves was estimated by spectrophotometric method (Pratibha and Korwar, 1999). The deterioration of leaf color in different treatments due to drying and storage was assessed by estimating the chlorophyll content in fresh dried leaves and the stored leaf at 3 months interval as per the standard procedure (Ranganna, 1986).

Statistical analysis

The drying experiment was conducted in randomized block design while the storage method was done in factorial design. The data were analyzed statistically using a general linear model for analysis of variance (Wilkinson *et al*., 1996). The data represent the average of 3 replicates, significance between control and treatments were compared at 0.05 probability levels.

Results and Discussion

The ambient temperature, RH and air velocity were 14.1-29.5^0 C, 33-82% and 3.5 km/h, respectively during drying time. The average daily solar radiation was 10 h during the season. The average chlorophyll and moisture content of fresh leaf was 278 mg/100 g, and 85%, respectively.

Drying time

The drying time of henna leaves was significantly influenced by different drying methods (Table 1). Among different drying methods, shade drying took longer time (86 h) followed by open air (Sun) drying (72 h). However, drying in CRIDA dryer at 60, 50 and 40^0C took 2.5, 3 and 5 h respectively. This may be due to the maintenance of the set temperature with automatic gas flow controller.

Leaf quality and color

The leaf quality (lawsone content and color) was influenced by different drying methods (Table 1). The henna leaf dried in open and shade drying recorded lower lawsone content as compared to the leaf dried in

Table 1 : Influence of different drying methods on the drying time, lawsone content and color of the leaf.

Drying method	Drying time (h)	Lawsone (%)	Chlorophyll (mg/100 g)	Colour
Sun	72	2.30	122	Brown
Shade	86	2.38	149	Greenish brown
40° C CRIDA dryer	5	2.45	208	Greenish brown
50° C CRIDA dryer	3	2.75	232	Green
60° C CRIDA dryer	2.5	2.40	188	Yellowish brown
Fresh leaf	-	2.90	278	
CD (P=0.05)	-	0.14	48.9	-

CRIDA dryer at all temperatures. In addition, the leaf dried in CRIDA dryer at 50°C recorded 10, 12, 13 and 16% higher lawsone content as compared to 40 and 60°C, shade and sun drying, respectively.

In another experiment the henna leaf was dried in CRIDA dryer at 50°C under two different humidities. The humidity in the dryer influenced the drying time and quality of leaf. The lawsone content of leaf was better when the leaf was dried at 33% (3.23%) as compared to 45% humidity (2.09%).

The color of the leaf dried in CRIDA dryer was better in terms of chlorophyll content of the leaf (Table 1). Highest chlorophyll content was recorded in leaf dried in CRIDA dryer at 50°C (232 mg/100 g) and lowest in sundried sample (122 mg/100 g). Sun dried leaf was brown in color, where as the leaf dried at 40 and 50°C in CRIDA dryer was green in color and was appealing. The higher lawsone content and color of leaf dried at 50°C may be due to maintenance of uniform temperature throughout drying time and less time of exposure to temperatures.

Shelf life of henna

The lawsone content of henna leaf decreased during storage irrespective of the drying methods. The decrease in lawsone content during storage varied from 20-60% depending on the drying methods by the end of 12 months. The leaf dried in CRIDA dryer had better shelf life as compared to open air and shade drying (Table 2). In open air and shade dry conditions, 56 and 60% loss in lawsone content was observed in HDPE cover and brown cover, respectively. Where as in leaf dried with CRIDA dryer, only 26-34% loss of lawsone content was recorded in different storage methods.

Furthermore, deterioration in quality of henna powder as indicated by lawsone content was less when the leaf was stored in 40 µ HDPE cover as compared to brown cover irrespective of drying methods. The quality of henna leaf was not influenced by the light when it was stored at room temperature.

The color of the leaf powder was also decreased on storage which was evident by the decrease in chlorophyll

Table 2 : Influence of different drying and storage methods on lawsone content (%) of henna

Method of drying	Storage period (months)											
	3			6			9			12		
	PC	BC	Mean	PC	BC	Mean	PC	BC	Mean	PC	BC	Mean
CRIDA dryer 40°	2.40	2.20	2.30	2.23	2.10	2.17	1.94	1.88	1.91	1.90	1.75	1.83
50°	2.55	2.45	2.50	2.49	2.33	2.41	2.39	2.22	2.31	2.32	2.03	2.18
60°	2.38	2.13	2.26	2.28	2.15	2.22	1.88	1.81	1.85	1.66	1.57	1.62
Open air (Sun)	2.21	1.85	2.03	2.02	1.85	1.94	1.61	1.43	1.52	1.00	0.84	0.92
Shade dry	2.32	2.20	2.26	2.10	1.96	2.03	1.76	1.63	1.70	1.29	1.11	1.20
Mean	2.37	2.17	2.27	2.22	2.08	2.15	1.92	1.79	1.86	1.63	1.46	1.55
Source of variation		CD			CD			CD			CD	
Drying methods		0.18			0.078			0.15			0.19	
Storage		0.19			0.11			0.1			0.15	
Drying X storage methods		NS			NS			NS			NS	

PC: Plastic cover; BC: Brown cover

Table 3 : Influence of different drying and storage methods on chlorophyll content (mg/100 g) of henna

Method of drying	Storage period (months)											
	3			6			9			12		
	PC	BC	Mean	PC	BC	Mean	PC	BC	Mean	PC	BC	Mean
CRIDA dryer 40^0	195	178	191	191	163	182	175	152	163	144	119	136
50^0	221	211	216	216	180	195	197	158	177	184	148	166
60^0	172	156	164	163	131	147	153	119	136	130	103	116
Open air(Sun)	106	101	103	94	80	89	74	65	69	52	36	44
Shade dry	138	131	134	111	105	108	92	85	88	80	61	70
Mean	166	157		154	134		136	117		118	95	
CD (P=0.05)												
Drying method		22			14			11			20	
Storage method		9			15			14			22	
Drying method x Storage method		NS			NS			NS			NS	

PC: Plastic cover; BC: Brown cover

(Table 3). The decrease in chlorophyll content of the leaf was significantly influenced by both the drying temperature and storage method. But the decrease in chlorophyll content of henna leaf was less in dried samples using CRIDA dryer as compared to open air drying and sun drying (Table 3). The chlorophyll content of henna leaf stored in 40 µ HDPE cover was higher as compared to brown covers. This might be due to reduction of chlorophyllase activity and conversion to pheophytin. Similar results were observed in curry leaf by Singh and Sagar (2010).

Fuel consumption and economics of drying

Energy consumption for drying of henna leaves was influenced by drying temperatures in CRIDA dryer. Drying at 50^0C consumed less fuel (1.2 kg LPG Gas) as compared to 40^oC (2.5 kg) and was almost equal to 60^0C (1.1 kg). The expenditure spent on gas for drying at 40, 50 and 60^0C was ₹ 110, 53 and 48, respectively. The additional expenditure spent on gas in mechanical dryer can be compensated by reduced labor cost and the product is likely to fetch higher price due to better quality and acceptability.

Conclusion

Drying of henna leaf at different drying temperatures and storage conditions revealed that a better quality leaf was obtained when leaf was dried in CRIDA dryer at 50^0C as compared to open and shade drying. Furthermore, the expenditure spent on gas can be compensated by reduced labor cost and better quality product. The shelf life of dried henna leaves was more when stored in HDPE cover of 40 µ thickness at room temperature.

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