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Effect of Sulphuring on Physical Parameters of Dry Ginger (*Zingiber officinale*) Genotypes

Nagireddy Manasa[1], Sadashiv Nadukeri[2*], Shashikala S. Kolakar[3], Kantharaj Y.[4], Ganapathi, M.[5] and Raviraja Shetty G.[6]

[1]M.Sc. (Hort.), Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mudigere (Karnataka), India.
[2]Assistant Professor, Farm Superintendent, AHRS, Bavikere (Karnataka), India.
[3]Assistant Professor, Department of GPB, AINPT, ZAHRS, Shivamogga.
[4]Department of PHT, College of Horticulture, Mudigere (Karnataka), India.
[5]Assistant Professor, Farm Superintendent, ZAHRS, Mudigere (Karnataka), India.
[6]Associate Professor, AHRS, Ullal, Mangalore (Karnataka), India.

(Corresponding author: Sadashiv Nadukeri)*
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ABSTRACT: An experiment was carried out to evaluate the effect of sulphuring on physical parameters of dried ginger (*Zingiber officinale* Rosc.) genotypes at COH, Mudigere during 2021-2022. The experiment was laid out in a Factorial Randomized Complete Block Design. *Zingiber officinale* Rosc. is a rhizomatous perennial herb spice crop in the Zingiberaceae family. About 30 per cent of the ginger that is produced in India is turned into dried ginger, 50 per cent is used as green or fresh ginger, and the remaining 40 per cent is utilised as seed. Farmers now a days practicing sulphuring or sulphitation while drying ginger to get bleaching effect which is harmful to farmers as well as consumers. This research was conducted to know the safe level of sulphur concentration for drying ginger. Peeled, whole ginger rhizomes were sulphured for 12 hrs and were dried under polytunnel dryer at 60°C. The results from the experiments can be concluded that, Maran and Himachal varieties are best suitable for producing dry ginger and the maximum dry weight was noticed in Maran (1.76 kg) and the highest dry matter was noticed in Himachal (7.42g) at 3.5 (g/kg) sulphur concentration.

Keywords: Pre-treatment, sulphuring, dried ginger, dry recovery percentage, polytunnel drying method.

INTRODUCTION

Zingiber officinale Rosc. is a rhizomatous perennial herb spice crop in the Zingiberaceae family. Southeast Asia is the sole home of this plant (Pyrseglove *et al.*, 1981). It is one of the earliest known spices and is grown in India in both fresh and dried forms. The Gingi district of India is home to more than 85 fragrant plants native to tropical Australia and East Asia, where ginger tea is used to soothe upset stomachs. Ginger is a perennial herb with a thick, spreading tuberous rhizome that reaches a height of about 3 to 4 feet (Lawrence and Tobacco 1984). There are roughly 150 species in all, the majority of which are large-rhizome tropical perennials. With more than 1200 plant species broken down into 53 genera, the ginger family is widely represented in Indo-Malaysia. Additionally, the East Asian and tropical Australian fragrant plant genus Zingiber contains about 85 species (Lucien and Foster 2000).

Along with Taiwan, Nepal, China, Nigeria, Thailand, Australia, Japan, Fiji, and Indonesia, India is the largest country in the world for ginger cultivation and production, accounting for 31per cent of the total global output (Bag, 2018). In India, ginger was grown on 0.018 million hectares in 2019–20, increasing from 0.016 million hectares in 2018–19, with a total yield of 1.78 million metric tonnes. The five states that produce the most ginger commercially are Assam, Maharashtra, West Bengal, Gujarat, and Kerala. These varieties include Wayand, Palakkadu, Idukki, Alappuzha, Rio de Janeiro, Thingpui, Maran, Nadia, Suprabha, Suruchi, Surabhi, Himagiri, IISR-Rejatha, IISR-Mahima, IISR-Varada, Manantoddy, among in 2020–2021, ginger worth 4.97 million USD was exported from India to the USA. It accounted for about 17.56 percent of all exports of ginger (Anon., 2021).

Kerala is the top Indian state for dry ginger production, accounting for a significant portion of exports and is followed by Karnataka (Bag, 2018). The lack of a value chain and effective pre- and post-harvest management has resulted in enormous losses for the ginger producers. It has been estimated that up to 30 per cent of ginger is lost after harvest (Dash *et al.*, 2015). About 30 per cent of the ginger that is produced in India is turned into dried ginger, 50 per cent is used as green or

fresh ginger, and the remaining 40 per cent is utilised as seed.

In the spice industry, dry ginger is used to manufacture crushed ginger and extract oleoresin and oil. It manifests physically in a variety of ways. It can be partially peeled or roughly scraped, peeled (coated or uncoated), or non-peeled (coated or unpeeled). Without causing any damage to the underlying tissue in the scraped grade, the cork peel has been carefully removed. Additionally, there are "bleached" and "limed" grades available. They are made from completely peeled or partially peeled whole rhizomes that have been imparted a white colour by being treated with lime or sulfuric acid. Hiranmayee (2020) reported that, peeled rhizomes soaked in lime water (2.0%) for six hours or fumigated with Sulphur for 12 hours to obtain good quality dried ginger.

Pre-treatment improves nutritional, sensorial and functional properties of the dehydrated food without changing its integrity. It also improves the texture as well as stability of the pigment during dehydration and the storage of dehydrated product (Al-Amin *et al.*, 2015). After a thorough washing, Jamaican ginger is carefully peeled with a special knife and dried in the sun. Indian ginger is roughly scraped and neither bleached nor unbleached (limed). The skin is partially scraped off with a sharp piece of bamboo or knife.

If we look into the effect of sulphur treatment in others crops of same family zingiberacae; Sulphur bleaching of dry cardamom capsules is widely practised to obtain white cardamom. Here the capsules were soaked in bleaching powder solution (20 g per litre of water) for one hour and spread on wooden trays, which were arranged inside airtight chambers. Sulphur dioxide produced by burning sulphur (15 g per kg of capsules) and made to pass over the trays. The process of soaking and drying was carried out 3 to 4 times depending on the intensity of the white colour required. The bleached cardamom was creamy white or golden yellow in colour (Krishnamurthy *et al.*, 2008).

The majority of producing nations rely on conventional method that mostly rely on physical labour. The quality of dried ginger is primarily determined by its appearance, volatile oil and fibre content, pungency level, aroma, and flavour. The best-looking dried ginger that has been thoroughly peeled is typically available in supermarkets. To produce powdered mixed spices, lower grades of clean peeled, coated whole, split, and sliced kinds are mixed. Oil distillation and oleoresin extraction can be done with any variety, but coated forms are the most popular (Vasala, 2012). Farmers have recently started employing the sulphur treatment to dry ginger after scraping it, giving the end product a bleaching effect and a good colour. Sulphur is harmful to consumers at higher concentrations, though.

MATERIAL AND METHODS

Completely matured, nine months old three varieties of ginger viz., Rio de Janeiro, Himachal and Maran which were free from pest and diseases were procured from local farmer S.R. Saju of Chittakodige village, Narasimharajapurataluk, Chikkamagulur district, Karnataka was used for the experiment.

Sample Preparation. The fresh, fully matured and diseases free ginger samples were peeled and cleaned by removal of unwanted material like dust, dirt etc. The rhizomes after thorough washing were peeled carefully with a stain less steel knife to remove a very thin layer as most of the oil glands were present immediately under the skin. Peeled samples were further dried by different drying methods after sulphuring them at different concentrations of sulphur with the interval of 0.5 ranging from 0.5 g/kg to 5.0 g/kg.

Sulphuring Treatment. A total of 88 kg of each variety of fresh ginger after washing, cleaning and peeling were used in 3 repetitions. The powdered sulphur dosage was calculated based on the treatment concentration. A total of 6.6 kg of sulphur powder was used. Peeled, whole ginger rhizomes were kept as a heap and these samples were sulphured by burning powdered sulphur at the centre, later covered with the help of tarpaulin for 12 hrs and the sulphured ginger samples were dried under polytunnel dryer. Drying for the present investigation was done at Mariappa farm in the village of Sakharayapatnam, Kadurtaluk, Chikkamagluru district which was at a distance of 52.2 km from the College of Horticulture, Mudigere. Polytunnel drying consists of an electric heater of 5 KW and solar energy for heating the atmospheric air and a fan to circulate air inside the chamber. The temperature maintained in drier was 60^{o}C and the samples were dried till the moisture content of 7 to 9 per cent.

Observations on all physical parameters were recorded from randomly selected samples in three replications from each treatment. The various observations recorded are as under.

Estimation of initial Moisture content (%). The moisture content of ginger rhizomes from different treatments before and after drying was estimated by using of instant moisture analyzer. Moisture loss from the ginger rhizomes in each drying method was estimated from the weight loss and measurement of initial moisture content. It was denoted in percentage. The initial moisture content of varieties such as Himachal, Maran and Rio de Janeiro were observed as 75.58, 78.11 and 84.90 per cent respectively.

Percent Dry Recovery. Dry recovery for dried ginger rhizomes by different drying methods was calculated from the weight of peeled ginger rhizomes and the weight of dried ginger. Dry recovery was expressed in percentage.

$$\text{Dry recovery (\%)} = \frac{\text{Weight of dried sample (kg)}}{\text{Weight of fresh sample (kg)}} \times 100$$

Dry Weight of Ginger (Kg). It was calculated by taking the weight of dried samples after different drying treatments by digital weighing balance (Model Name/Number TTB 3). It was measured in grams.

Dehydration Ratio. The dehydration ratio can be calculated by dividing the weight of the dried sample by the weight of the fresh sample (Kaur *et al.*, 2008).

$$\text{Dehydration ratio} = \frac{\text{Weight of dried sample (g)}}{\text{Weight of fresh sample (g)}}$$

Dry Matter content (g). Dry matter content for dried ginger rhizomes by different drying methods was calculated from the weight of dried ginger rhizomes after complete removal of moisture at 108 °C till the same weight obtained for continuous three times. (Casimero *et al.*, 2021).

RESULTS AND DISCUSSION

A. Effect of different concentrations of sulphur on physical parameters

The sulphur concentration had an effect on dry recovery percentage, dehydration ratio, dry matter content, and dry weight across all treatments. The dry recovery percentages at various administered sulphur concentrations were found to be comparable, with values ranging from 15.28 per cent dry recovery at 0.5 g/kg concentration to 16.85 per cent dry recovery at 3.5 g/kg concentration, but the treatment with no sulphur recorded the lowest dry recovery value (12.71 %).

The dry matter content at 4.5 g/kg sulphur concentration (5.96 g) was the highest and was comparable to the concentrations at 2.5, 4.0 and1.0 g/kg, which showed 5.82, 5.75 and 5.73 grammes of dry matter respectively. The results of the dry weight at various sulphur concentrations follow the same trend as the dry matter content, with all dry weights being significantly non-different, with the control showing the lowest value of 1.02 (kg). The increase in dry matter content, dehydration ratio and dry weight under sulphur treated rhizome might be due to bleaching effect. These results are in line with the agreement of Cantin *et al.* (2012).

B. Effect of different varieties on physical parameters

The dry recovery percentage and dry weight of the varieties differed significantly, with Maran recording greater value (19.54 % and 1.56 kg). Each variety differed greatly from the others in terms of dehydration ratio and dry matter content. The highest dehydration ratio and dry matter content in Maran (0.20) and Himachal (7.42 g) respectively and the lowest values were noticed in Rio de Janeiro (0.11) and Rio de Janeiro (3.97 g). Those varied higher values in a specific variety could be related to the genetic makeup of that variety. These results are in agreement with Narode (2015).

C. Physical parameters as influenced by combined effect of varieties and sulphur concentrations

In terms of the interaction between varieties and sulphur concentration, dry recovery percentage, dehydration ratio shown non-significant. The Maran had the highest dry weight at 1.5 (g/kg) sulphur concentration 1.76 kg, which was comparable to the other treatments, such as 2.5 and 0.5 (g/kg) with values of 1.69 kg and 1.67 kg respectively.

The interaction effect of variety and sulphur concentration on dry matter content in grams was found to be significant, with the highest being observed in Himachal at 5.0 and 3.5 (g/kg) with 8.50 and 8.43 (g) sequentially. This might be due to the use of sulphur at higher concentration to the high fibre content variety *viz*., Himachal and Maran results in more dry recovery and dry matter content. Results of the present findings are in line with the observation made by Bojtepe *et al*. (2016) in grape.

Table 1: Effect of Sulphur concentration on dry recovery in ginger (*Zingiber officinale* Rosc.) varieties under polytunnel drying.

Concentration of Sulphur (g/kg)	Dry recovery (%)			Mean
	Himachal	Riode Janeiro	Maran	
C_1 - 0.5	13.37	11.62	20.83	15.28^{d}
C_1 - 1.0	16.97	11.37	17.96	15.44^{cd}
C_1 - 1.5	16.62	10.60	19.92	15.72^{c}
C_1 - 2.0	15.50	12.30	18.92	15.56^{cd}
C_1 - 2.5	14.27	12.00	21.15	15.81^{c}
C_1 - 3.0	17.72	11.67	19.57	16.33^{b}
C_1 - 3.5	18.22	11.87	20.45	16.85^{a}
C_1 - 4.0	16.72	11.47	20.42	16.21^{b}
C_1 - 4.5	16.22	10.53	22.05	16.27^{b}
C_1 - 5.0	16.92	13.62	18.90	16.48b
Control (no Sulphur)	14.38	9.00	14.75	12.71^{e}
Mean	16.08^{b}	11.46^{c}	19.54^{a}	
	C	**V**	**C × V**	
SEm(±)	0.665	0.347	1.152	
CD @ 5 %	1.882	0.983	NS	

V= Variety; C = Concentration of Sulphur; C ×V = Interaction

Table 2: Effect of Sulphur concentration on dry weight in ginger (*Zingiber officinale* Rosc.) varieties under polytunnel drying.

Concentration of Sulphur (g/kg)	Dry weight(kg)			Mean
	Himachal	Riode Janeiro	Maran	
C_1 - 0.5	1.07	0.93	1.67	1.2[a]
C_1 - 1.0	1.36	0.91	1.44	1.24[a]
C_1 - 1.5	1.33	0.85	1.59	1.26[a]
C_1 - 2.0	1.24	0.98	1.51	1.25[a]
C_1 - 2.5	1.14	0.96	1.69	1.27[a]
C_1 - 3.0	1.42	0.93	1.57	1.31[a]
C_1 - 3.5	1.46	0.95	1.64	1.35[a]
C_1 - 4.0	1.34	0.92	1.63	1.23[a]
C_1 - 4.5	1.30	0.84	1.76	1.30[a]
C_1 - 5.0	1.35	1.09	1.51	1.32[a]
Control (no Sulphur)	1.15	0.72	1.18	1.02[b]
Mean	1.29[b]	0.92[c]	1.56[a]	
	C	**V**	**C×V**	
SEm(±)	0.44	0.23	0.75	
CD @ 5 %	1.23	0.64	2.13	

V = Variety; C = Concentration of Sulphur; C ×V = Interaction

Table 3: Effect of Sulphur concentration on dehydration ratio in ginger (*Zingiber officinale* Rosc.) varieties under polytunnel drying.

Concentration of Sulphur (g/kg)	Dehydration Ratio			Mean
	Himachal	Rio de Janeiro	Maran	
C_1 - 0.5	0.13	0.12	0.21	0.15 [a]
C_1 - 1.0	0.17	0.11	0.18	0.15 [a]
C_1 - 1.5	0.17	0.11	0.20	0.16 [a]
C_1 - 2.0	0.16	0.12	0.19	0.16[a]
C_1 - 2.5	0.14	0.12	0.21	0.16 [a]
C_1 - 3.0	0.18	0.12	0.20	0.16 [a]
C_1 - 3.5	0.18	0.12	0.21	0.17 [a]
C_1 - 4.0	0.17	0.12	0.20	0.16[a]
C_1 - 4.5	0.16	0.11	0.22	0.16[a]
C_1 - 5.0	0.17	0.14	0.19	0.16[a]
Control (no Sulphur)	0.14	0.09	0.15	0.13 [a]
Mean	0.16[ab]	0.11[b]	0.20 [a]	
	C	**V**	**C×V**	
SEm(±)	0.008	0.004	0.014	
CD @ 5 %	NS	0.012	NS	

V = Variety; C = Concentration of Sulphur; C × V = Interaction

Table 4: Effect of Sulphur concentration on dry matter content in ginger (*Zingiber officinale* Rosc.) varieties under polytunnel drying.

Concentration of Sulphur (g/kg)	Dry matter content (g)			Mean
	Himachal	Riode Janeiro	Maran	
C_1 - 0.5	6.34	4.29	4.91	5.18[b]
C_1 - 1.0	7.42	3.89	4.49	5.26[b]
C_1 - 1.5	7.57	4.11	4.64	5.44[a]
C_1 - 2.0	7.13	4.28	5.45	5.62[a]
C_1 - 2.5	7.72	3.90	4.98	5.53[a]
C_1 - 3.0	7.33	3.73	6.01	5.69[a]
C_1 - 3.5	8.43	4.02	5.02	5.82[a]
C_1 - 4.0	7.79	4.57	4.89	5.75[a]
C_1 - 4.5	7.60	3.80	6.48	5.96[a]
C_1 - 5.0	8.50	3.54	5.16	5.73[a]
Control (noSulphur)	5.75	3.49	3.65	4.29[b]
Mean	7.42[a]	3.97[c]	5.06[b]	
	C	**V**	**C×V**	
SEm(±)	0.49	0.064	0.214	
CD @ 5 %	0.349	0.183	0.605	

V = Variety; C = Concentration of Sulphur; C × V = Interaction

CONCLUSION

Among the different varieties, the physical parameters were found to be the best in the Maran and Himachal varieties for dry weight and dry recovery percentage, which were major contribution to the final dry yield and 3.5 g/kg of sulphur concentration was found to be superior for all physical parameters.

FUTURE SCOPE

Research to be carried out to study the effect of sulphuring on the quality parameters of ginger.

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Conflict of Interest. None.

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