

Variability for quality traits in a global germplasm collection of ginger (*Zingiber officinale* R.)

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Abstract

Forty six ginger accessions originating from India, China, Pakistan, Brazil, Jamaica, Oman, Nepal, Nigeria and Queensland analysed for the quality attributes revealed that the primitive types/land races are rich in oleoresin and essential oil and low in crude fiber content as compared to the improved varieties.

Key words : *Zingiber officinale*, germplasm, oleoresin, crude fiber and essential oil

Introduction

Ginger (*Zingiber officinale* Rosc.) is a major spice and medicine used all over the world. Ginger has been used as a medicine in Chinese, Indian and Arabic herbal traditions since ancient times (1). Characterized by its typical flavour and aroma, ginger is noted for its richness in oleoresin, essential oil and fiber contents. Ginger is commercially available in various forms such as fresh ginger, dry ginger, ginger powder, ginger oil, ginger oleoresin and preserved ginger. China and India are the two major producers of ginger. Cultivar diversity of ginger is very high in China, followed by India (2). The main ginger growing countries other than India and China are Jamaica, Taiwan, Sierra Leone, Nigeria, Fiji, Mauritius, Indonesia, Brazil, Costa Rica, Ghana, Malaysia, Bangladesh, Philippines, Sri Lanka, Thailand,

Trinidad, Uganda, Hawaii, Guatemala and many Pacific Ocean Islands (3).

Ginger is known to vary widely for the quality traits besides yield (4). A critical analysis of variability for the important quality traits in the germplasm from different sources grown under uniform conditions/season will help us to know the spectrum of variability for oleoresin, essential oil and crude fiber in this clonally propagated crop without the confounding effects of the micro and macro climatic factors.

Materials and Methods

a) Plant materials

Rhizomes of the ginger accessions were collected from Germplasm Conservatory of Indian Institute of Spices Research, Peruvannamuzhi, Kozhikode, Kerala, India, where the germplasm is grown in cement tubs (45x45x45cm) under partial (50%) shade with half of the recommended fertilizers. This germplasm repository houses one of the world's largest collections of ginger germplasm under *Ex situ* condition. Forty six ginger (*Zingiber officinale* Rosc.) accessions, which include released varieties, exotic and primitive types were used in the study (Table. 1)

b) Extraction of oleoresin

Oleoresin was extracted from the, dried and powdered rhizome in acetone. Ten grams of the sample was weighed and transferred to a glass column (18 x 450mm) with stopcock. Added 50ml of acetone. Allowed to stand overnight for 16 hrs at 25±2°C. The filtrate extracted through non absorbent cotton was collected in a pre-weighed 100ml beaker. Column was washed with 20ml of acetone. The extracts were pooled and evaporated to dry at 80°C over a water bath. The amount of oleoresin was estimated gravimetrically (5).

c) Estimation of crude fibre

Crude fiber from the powdered ginger sample was estimated by using a Dosi-Fibre apparatus (J.P.Selecta, SPAIN). For determining crude fibre, the organic matter in the dried residue remaining after digesting the sample with distilled sulphuric acid and sodium hydroxide was weighed (5).

d) Essential oil

The steam volatile oil from ginger was extracted by using a modified Clevenger method. The apparatus was assembled using the proper Clevenger trap (5) and was boiled for 2 1/2 hrs.

Results and Discussion

a) Oleoresin

Flavour and pungency of ginger are accumulated in the oleoresin. The oleoresin yield of the 46 ginger accessions are given in Table 2. The primitive types/land races from India registered high oleoresin content. The oleoresin content of the 46 ginger accessions ranged from 3 ('Acc. No. 59') to 82% ('Kozhikkalan'). Other primitive type ginger like 'Kakakkalan', 'Sabarimala' etc. also recorded high oleoresin yield. Higher percentage of oleoresin content in the primitive type ginger 'Kozhikkalan' is

reported (6). Some other collections (land races) of ginger such as 'Vizagapatnam-1', 'Pulpally' & 'Neyyar' also showed high oleoresin percentage. Oleoresin content in ginger can range from 3 to 11% (7).

Genotypes, harvesting age, cultivation practices, choice of solvents and method of extraction etc. are known to affect the oleoresin content in ginger (8). In the present study all factors except the genotypes being common, the variability observed for oleoresin may be attributed to the effect of the cultivars. The primitive types/land races ('Kozhikkalan', 'Sabarimala', 'Pulpally', 'Vizagapatnam-1', 'Neyyar', 'Jolpaiguri' etc.) can be a better source for commercial exploitation of oleoresin.

b) Crude fiber

Crude fiber content of the ginger accessions are given in Table 2. Among the 46 ginger accessions, the exotic ginger 'Kintoki' and cultivar 'Nadia' recorded 1.3% and 1.8% crude fiber, respectively. Most of the other ginger accessions recorded about 4-5% crude fiber. High crude fiber (< 7%) was observed in the ginger accessions 'Pulpally', 'Todupuzha' and 'Vizagapattanam'. Crude fiber content in ginger usually ranges from 4.8 to 9% (9).

Fiber content is the most important criteria for assessing the suitability of ginger rhizome for specific products like ginger paste, salted ginger, ginger powder etc. For the manufacture of processed food such as jams, marmalades, cakes and confectionery too less fiber gingers are more suitable, though both low fiber and high fiber gingers are important depending on the end use. In the present study cultivars such as 'Kintoki, and 'Nadia' recorded very less fiber and hence can be exploited for making value added products like slices preserved in syrup, ginger candy (crystallised ginger), jams, cakes etc. whereas the cultivars such as 'Suruchi', 'Oman', 'Pulpally,

'Thodupuzha-2', 'Kottayam', 'Wyanad local', 'Vizagapatnam-1', which recorded high fiber content will be useful for dry ginger making.

c) Essential oil

Cumulative effect of the essential oil components imparts the perfumery smell to ginger/the essential oil. Essential oil from dried rhizomes of ginger cultivars/varieties are given in Table 2. The yield of ginger essential oil ranged from 0.9 to 4%. Highest percentage of essential oil content was observed in the 'Pink ginger' (4%) followed by 'Kakakkalan' (3.5%) and 'Kozhikkalan' (3%). 'Pink ginger' is a local land race of Nagaland, India and the tribal folk there prefer it as an ethnic medicine besides in a variety of meat dishes. The lowest percentage of essential oil was recorded in the cultivar 'Mananthodi' (0.9%) and exotic ginger from 'Pakistan' (0.9%). Yield of the essential oil in ginger ranges from 0.2 to 3.0%, depending on the origin and state of the rhizome (10,11). Primitive ginger from Kerala, India, namely 'Kozhikkalan' is reported to be rich in essential oil (6). The high essential oil yielding 'Pink ginger', 'Kozhikkalan' and 'Kakakkaln' can be better suited for the perfume industry.

Though the values of oleoresin, essential oil and fibre content observed in the present study are within the range reported for these constituents (7,9,10,11) some variation in the same accessions eg 'Kottayam', 'Wynadu Local', 'Thodupuzha' and 'Suruchi' from the earlier reported values was observed. This may be due to the growing conditions of the germplasm. Quality of ginger is known to be influenced by the environment, growing conditions and the levels of shade (4,12,13).

The present study thus indicated the suitability of different genotypes namely, 'Kozhikkalan', 'Sabarimala', (primitive types from India) 'Pulpally', 'Vizagapatnam-1',

'Neyyar', 'Jolpaiguri' (land races from India) for high oleoresin; 'Kintoki' and 'Nadia' (land races from Japan/India) for less fiber content and 'Pink ginger', 'Kozhikkalan' and 'Kakakkalan' (all primitive types from India) for high essential oil.

In general, the primitive types/land races, though poor yielders (yield data not shown) were better source of the quality attributes as compared to the improved types. Breeding mainly directed for high yield might have had a negative impact on the quality traits. Further, the germplasm from India is found to be more variable, notwithstanding the less number of accessions studied from other countries. This is rather expected as the center of origin of the crop falls in this region.

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Table. 1. Ginger accessions studied

Sl. No	Name	Acc No.	Remark
1	'Varada'	64	Released variety from Indian Institute of Spices Research, Calicut, Kerala, India.
2	'Mahima'	117	Released variety from Indian Institute of Spices Research, Calicut, Kerala, India.
3	'Rejatha'	35	Released variety from Indian Institute of Spices Research, Calicut, Kerala, India.
4	'Suruchi'	714	Released variety from Orissa University of Agriculture & Technology, High Altitude Research Station, Pottangi, Koraput, Oriisa, India.
5	'Suprabha'	293	Released variety from Orissa University of Agriculture & Technology, High Altitude Research Station, Pottangi, Koraput, Orissa, India.
6	'Himachal'	294	Land race from Himachal Pradesh, India.
7	'Maran'	295	Land race from Assam, India.
8	'Nadia'	27	Land race from West Bengal, India.
9	'Karakkal'	20	Land race from Pondicherry, India.
10	'Mananthody'	244	Land race from Wynadu, Kerala, India.
11	'Sabarimala'	246	Primitive type Collected from Sabarimala forests, Western Ghats Kerala, (slender rhizome), India.
12	'Kozhikkalan'	537	Primitive type Collected from Nedumangad, Kerala (slender rhizome), India.
13	'Ellakallan'	463	Primitive type Collected from Idukki, Kerala (slender rhizome), India.
14	'Kakakkalan'	558	Primitive type Collected from Nedumangad, Kerala (slender rhizome), India.
15	'Pakistan'	733	From Pakistan.
16	'Oman'	734	From Oman.
17	'Brazil'	736	From Brazil.
18	'Jamaica'	17	From Jamaica originally.
19	'Rio-de-Janeiro'	59	From Brazil originally.
20	'Pink ginger'	731	Collected from Meghalaya state, India.
21	'Bakthapur'	563	From Nepal.
22	'Kintoki'	648	From Japan.
23	'Nepal'	575	Collected from Nepal.
24	'China'	9	Originally from China.
25	'Juggigan'	18	Originally from Nigeria.
26	'Acc. No. 50'	50	Kerala, India.
27	'Pulpally'	56	Collected from Pulpally, Kerala, India.
28	'Acc. No.95'	95	Kerala, India.
29	'Ambalawayalan'	109	Collected from Wynad, Kerala, India.
30	'Kozhikkode'	162	Collected from Kozhikkode, Kerala, India.
31	'Thodupuzha-1'	204	Collected from Thodupuzha, Kerala, India.
32	'Konni local'	206	Collected from Konni, Kerala, India.
33	'Angamali'	214	Collected from Angamali, Kerala, India.

34	'Thodupuzha -2'	217	Collected from Thodupuzha, Kerala, India. Collected from Kottayam, Kerala, India. Collected from Palai market, Kerala, India. Collected from Silent valley forests of Western Ghats, India.
35	'Kottayam'	225	
36	'Palai'	228	
37	'Silent valley'	240	
38	'Wyanad local'	251	Collected from Wyanad, Kerala, India.
39	'Vizagapatnam-1'	411	Collected from Vizagapatnam, Andrapradesh, India.
40	'Vizagapatnam-2'	420	Collected from Vizagapatnam, Andrapradesh, India.
41	'Fiji'	430	From Queensland.
42	'Gorubathani'	515	Collected from Sikkim, India.
43	'Bhaise'	552	Collected from Kalimpong, West Bengal, India.
44	'Naval parasi'	569	Collected from Nepal.
45	'Neyyar'	650	Collected from Neyyar, Kerala, India.
46	'Jolpaiguri'	654	Collected from Jalpaiguri, West Bengal, India.

Table 2. Oleoresin, crude fiber and essential oil percentage from dry rhizomes of ginger

Sl. No	Cultivar/ variety	Oleoresin (%)	Crude fiber (%)	Essential oil (%)	Sl. No.	Cultivar/ variety	Oleoresin (%)	Crude fiber (%)	Essential oil (%)
1	'Varada'	4.0	4.0	1.7	24	'China'	3.6	3.4	2.0
2	'Mahima'	3.7	4.8	2.1	25	'Juggigan'	4.4	3.5	1.9
3	'Rejatha'	3.6	5.8	1.0	26	'Acc. No.50'	5.3	4.5	1.9
4	'Suruchi'	3.9	6.8	1.7	27	'Pulpally'	7.0	7.2	1.9
5	'Suprabha'	4.0	4.2	1.9	28	'Acc. No.95'	3.6	5.3	1.8
6	'Himachal'	4.3	4.8	2.1	29	'Ambalawayalan'	4.5	5.3	2.1
7	'Maran'	4.3	3.7	1.1	30	'Kozhikkode'	5.1	5.6	1.6
8	'Nadia'	4.2	1.8	2.0	31	'Thodupuzha'	4.2	4.8	1.1
9	'Karakkal'	2.7	4.0	2.0	32	'Konni local'	5.3	5.9	1.8
10	'Mananthodi'	3.7	4.1	0.9	33	'Angamali'	5.1	4.3	1.7
11	'Sabarimala'	6.4	4.3	2.0	34	'Thodupuzha'	5.1	7.5	1.5
12	'Kozhikkalan'	8.2	4.3	3.0	35	'Kottayam'	5.6	8.0	1.7
13	'Ellakkallan'	3.4	4.1	2.4	36	'Palai'	3.4	4.2	1.0
14	'Kakakkalan'	5.6	5.3	3.5	37	'Silent valley'	4.7	2.8	1.8
15	'Pakistan'	4.6	3.8	0.9	38	'Wyanad local'	5.1	6.5	1.0
16	'Oman'	4.8	6.5	1.4	39	'Vizagapatnam'-1	7.1	7.0	2.0
17	'Brazil'	3.3	3.8	1.3	40	Vizagapatnam-2	5.0	4.6	1.3
18	'Jamaica'	3.9	5.5	2.3	41	'Fiji'	5.1	5.2	1.9
19	'Rio-de-Janeiro'	3.0	4.6	1.6	42	'Gorubathani'	4.8	4.1	1.3
20	'Pink ginger'	5.4	4.8	4.0	43	'Bhaise'	3.2	4.3	1.6
21	'Bakthapur'	4.8	4.4	1.7	44	'Naval parasi'	4.2	5.5	1.5
22	'Kintoki'	3.3	1.3	1.5	45	'Neyyar'	6.2	4.2	2.3
23	'Nepal'	5.0	5.3	1.8	46	'Jolpaiguri'	6.0	5.3	2.1