

## Gingerol content of different genotypes of ginger (*Zingiber officinale*)\*

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Ginger (*Zingiber officinale* Roscoe) is a monocotyledonous, sterile cultigen thought to have originated in India or south-east Asia, from where it was introduced to other parts of the world. The ginger rhizome is one of the most common constituents of diets worldwide and is reported to possess antioxidant, anti-inflammatory, antiseptic and carminative properties (Afzal *et al.* 2001). Gingerols, pungent principles of ginger are biologically active components that may make a significant contribution towards medicinal applications of ginger. Gingerol, however, are thermally labile due to the presence of  $\beta$ -hydroxy keto group and are converted under high temperature to [6]-, [8]-, and [10]-shogaols (Bhattarai *et al.* 2007). The content of the active principle is not uniform and can vary significantly between plant varieties and regions in which ginger is grown (Gruenwald 2004).

So far, there has not been a systematic study on quantification of pungent principle in different genotypes grown and consumed in India. Hence a study was conducted during 2007–08 to explore the variability of different genotypes of Indian ginger in terms of their content of pungent phenolic compounds to identify high-yielding genotypes for commercial cultivation for flavour or pharmaceutical use.

Eighteen genotypes of ginger, which were grown in different parts of India were selected. Some of them are released varieties while others are local genotypes that have the potential in terms of yield and pungency. These genotypes were grown in the experimental field of ICAR Research Complex for North Eastern Hill Region, Barapani, Meghalaya, India (latitude 26° N and 92° E, with an elevation of 950 m above mean sea level) in April during 2007–08. The soil was a sandy loam, acidic (pH 5.4), having an organic carbon content of 1.9%, with 286.97, 11.24 and 206.76 kg/ha available N, P and K respectively. The genotypes were harvested after 9 months of planting. Fresh rhizomes were

washed, and very light peeling was done to remove the upper skin and after that sample was cut into pieces. A 5 g sample was placed in a large centrifuge tube to which twice the sample mass of 99% methanol was added. The preparation was sonicated for 20 min. and subsequently centrifuged for 5 min. at 4 000 rpm. The supernatant was transferred to a glass vial and filtered through automation certified filter. To take account of variation between individual plants, 3 samples from different rhizomes were prepared for each genotype. The same method was followed after 4 months during which the rhizomes were stored at room temperature in open condition.

The gingerols and shogaols were analyzed through HPLC. Mobile phase A consisted of HPLC-grade water obtained from an in-house Milli-Q system; mobile phase B consisted of HPLC-grade acetonitrile; both contained 0.05% trifluoroacetic acid (Sigma-Aldrich, St. Louis, MO). The gradient eluting mobile phase was A/B (55: 45, v/v) to A/B (10: 90, v/v) over 20 min, followed by A/B (10: 90, v/v) for 10 min. Mobile phase was pumped at 1.3 ml/min, the column temperature was 40°C, and the injection volume was 10.0 ml. Data were collected using a SPD-M 10 Avp photo diode array detector collecting absorption spectra from 200 to 400 nm with quantification performed at 280nm. Synthetic standards of [6]-gingerol (99%), [8]-gingerol (99%), [10]-

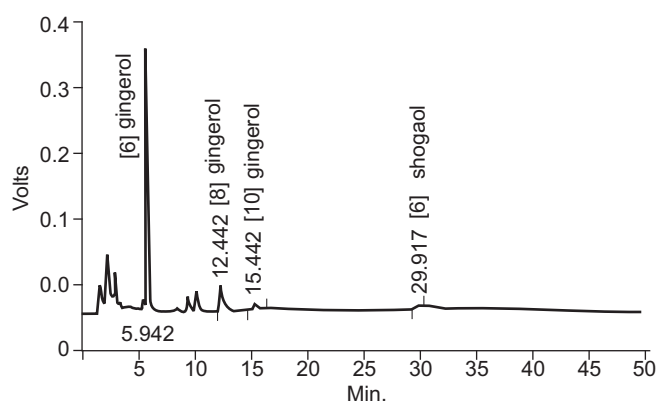


Fig 1 Typical HPLC chromatogram of methanolic extract of fresh ginger rhizome (Meghalaya Local) after 4 months storage

\* Short note

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Table 1 Per cent share of different gingerols and shogaols at 0 and 4 month period

Genotype	[6]-Gingerol		[8]-Gingerol		[10]-Gingerol		[6]-Shogaols	
	0 months	4 months	0 months	4 months	0 months	4 months	0 months	4 months
'Meghalaya Local'	88.65	84.60	9.08	8.85	2.27	2.03	Nil	4.50
'Maran'	74.16	67.33	10.34	10.89	15.51	15.84	Nil	5.94
'Jugijan'	71.72	61.64	11.48	10.96	16.80	16.44	Nil	10.96
'Nagaland Local'	77.20	64.71	7.95	6.72	14.86	13.45	Nil	15.13
'Suprabha'	78.41	62.67	8.98	8.00	12.62	12.00	Nil	17.33
'64 Vars'	71.74	60.00	10.30	10.00	17.96	17.50	Nil	12.50
'204 Vars'	70.54	59.82	10.50	9.82	18.97	17.86	Nil	12.50
'Nadia'	83.60	81.91	8.20	8.07	8.20	7.99	Nil	2.04
'Varada'	72.35	61.46	11.11	9.38	16.54	15.62	Nil	13.54
'China'	77.59	71.13	10.92	10.80	11.50	11.16	Nil	6.91
'Thingpui'	77.53	68.65	9.15	8.87	13.33	12.76	Nil	9.72
'Bhaisa'	73.31	65.17	9.96	8.80	16.73	15.48	Nil	10.56
'Mahima'	74.98	64.09	12.27	11.87	12.74	12.17	Nil	11.87
'Rajatha'	74.76	62.54	12.14	11.35	13.10	12.57	Nil	13.54
'Karakal'	76.73	65.29	11.73	11.46	11.54	11.15	Nil	12.10
'Pune'	71.67	62.67	10.58	9.28	17.75	16.40	Nil	11.65
'Ernad'	76.56	66.22	10.56	9.36	12.87	12.04	Nil	12.37
'Deomali'	76.87	67.83	10.64	9.39	12.48	11.13	Nil	11.66

gingerol (98%), and [6]-shogaol (99%) were obtained from Natural Remedies Private Limited, Bengaluru. Identification of gingerols and shogaols in samples was based on comparisons of retention time and UV-spectra with the standards. Quantification was based on standard curves prepared with pure standards. Statistical analyses of the experimental data was carried out by using SPSS package (version 10.0).

Eighteen different ginger genotypes were analyzed twice, just after harvesting and after 4 months storage. The mean concentrations of [6]-gingerol, [8]-gingerol, [10]-gingerol, and [6]-shogaol were calculated from the peak areas obtained at 280 nm (Fig 1). When the mean total gingerol content of each genotype was compared with the other genotypes most

of the genotypes except two showed statistically significant differences.

The concentrations of gingerols in freshly extracted ginger (0 months) are shown in Fig 2. The most abundant gingerol in all the genotypes was [6]-gingerol, which occurred at concentrations ranging from 1 030 to 3 049 µg/g of fresh rhizome (mean 1354.78±470 g/g). [8]-gingerol and [10]-gingerol occurred in lower concentration; [8]-gingerol ranged from 105 to 312 µg/ g (mean 180.94±45 mg/g) while [10]-gingerol ranged from 105 to 425 µg/g (mean 234±79 µg/g). [6]-gingerol was the most abundant gingerol in all the genotypes, which is in accordance with the literature

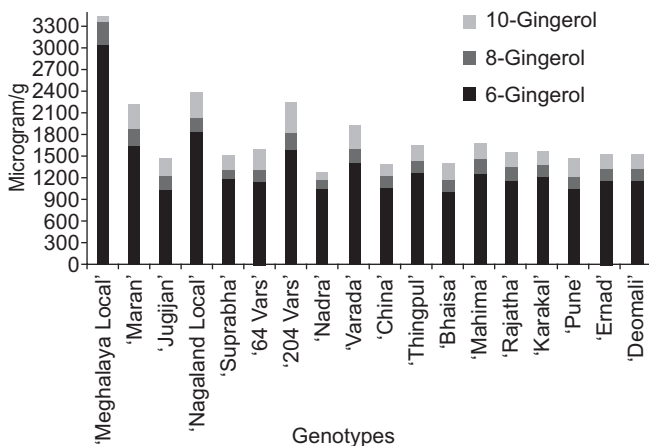


Fig 2 Concentrations of [6]-, [8]-, and [10]-gingerols in fresh rhizomes of 18 ginger genotypes

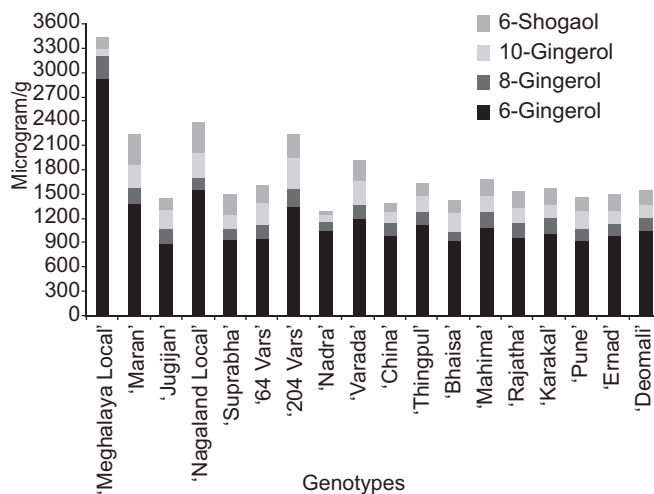


Fig 3 Concentrations of [6]-, [8]-, and [10]-gingerols and [6]-shogaols in fresh rhizomes of 18 ginger genotypes after 4 months storage

(Wohlmuth *et al.* 2005). The mean ratio of [6]-, [8]-and [10]-gingerols varied from genotype to genotype.

The mean content of gingerols obtained was considerably higher than those found by some earlier study (Young *et al.* 2002) but comparable with those found by Zhang *et al.* (1994). This variability may reflect genetic differences between genotypes in different regions or physiological response to environmental factors such as climate, soil characteristics, or predation, but they may also be due to differences in extraction and analytical methodologies. The genotype 'Meghalaya Local' contained the highest concentration of total gingerol (3 436 µg/g) as well as [6] and [8]-gingerols on fresh weight basis and was therefore the most pungent of the genotypes assayed. 'Meghalaya Local' may thus be suitable for commercial production of highly pungent ginger rhizomes with potential application in both the pharmaceutical and flavour industries. [6]-shogaol was not identified in any of the genotype in freshly prepared sample.

The concentration of gingerols extracted after 4 months of storage (January to April) at room temperature are shown in Fig 3. The minimum temperature during storage is 7.5°C and maximum is 28.4°C. The humidity ranges from 25 to 88%. The figure shows that quantity of total gingerol had decreased as compared to the quantity extracted at zero months. At this stage the quantity of [6]-shogaol was identified in all the samples. The concentration of [6]-shogaol ranged from 26 to 360 µg/g (mean 190.39±75.24 µg/g). The genotype 'Meghalaya Local' that had highest gingerol recorded lower amount of shogaols as compared to certain other genotypes. [6]-shogaol was identified in all the samples after 4 months of storage, while it was absent from fresh rhizomes. These findings support the hypothesis that shogaols are not native constituents of fresh ginger rhizomes but form from gingerols by dehydration as a result of heat treatment or alkaline or acidic conditions (Wohlmuth *et al.* 2005).

On the basis of HPLC data, the ratio of [6]-, [8]-and [10]-gingerol at 0 and 4 months and shogaols at 4 months only was calculated for 18 genotypes (Table 1). At 0 months of storage, the per cent share of [6]-gingerol is between 70 and 78% except two genotypes, 'Meghalaya Local' and 'Nadia' which had >80% of total gingerol. The per cent share of [8]-gingerol is 7–12%, while [10]-gingerol ranges from 2.27 to 18.97% of total gingerol. At 4 months of storage at room temperature, the per cent share of [6]-gingerol had changed.

This changed mainly because of the formation of [6]-shogaols. Since both [8]-and [10]-gingerol possess considerable pungency (albeit <[6]-gingerol) (Nakasone *et al.* 1999), the relatively high level of [8]-gingerol present in 'Meghalaya Local' in addition to the very high concentration of [6]-gingerol make this genotype by far the most pungent of the 18 genotypes assessed.

#### SUMMARY

The findings show the variability of gingerol compounds in Indian commercial and experimental ginger genotypes. The genotype 'Meghalaya Local' contained the highest concentration of total gingerol and was therefore the most pungent of the genotypes assessed. 'Meghalaya Local' may thus be suitable for commercial production of highly pungent ginger rhizomes with potential application in both the pharmaceutical and flavour industries.

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#### REFERENCES

- Afzal M, Al-Hadidi D, Menon M, Pesek, J and Dhami M S. 2001. Ginger: an ethnomedical, chemical and pharmacological review. *Drug Metabolism and Disposition* **18**: 159–90.
- Bhattarai S, Tran V H and Duke C C. 2007. The stability of gingerol and shogaol in aqueous solutions. *Biochemical Biophysics Research Communication* **362**: 218–23.
- Gruenwald L. 2004. *PDR for Herbal Medicine*. 3rd edn. Montvale, NJ: Thomson PDR.
- Nakasone Y, Yonaha M, Wada K, Adaniya S, Kikuzaki H and Nakatani N. 1999. Evaluation of pungency in the diploid and tetraploid types of ginger (*Zingiber officinale* Roscoe) and antioxidative activity of their methanol extracts. *Japanese Journal of Tropical Agriculture* **43**: 71–5.
- Wohlmuth H, Leach D N, Smith M K and Myers S P. 2005. Gingerol content of diploid and tetraploid clones of ginger (*Zingiber officinale* Roscoe). *Journal of Agricultural and Food Chemistry* **53**: 5772–8.
- Young H Y, Chiang C T, Huang Y L, Pan F P and Chen G L. 2002. Analytical and stability studies of ginger preparations. *Journal of Food Drug Analysis* **10**: 149–53.
- Zhang X, Iwaoka W T, Huang A S, Nakamoto S T and Wong R. 1994. Gingerol decreases after processing and storage of ginger. *Journal of Food Science* **59**: 1338.