



Short communication

Antioxidant-rich amaranth varieties, Arka Samraksha and Arka Varna

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ABSTRACT

Amaranth improvement in India hitherto was concerned with development of high-yielding varieties, and hardly any research efforts have been made for its nutritional improvement. Keeping this in view, at Indian Institute of Horticultural Research two high-yielding amaranth varieties, Arka Samraksha and Arka Varna with high antioxidant activity, low amounts of nitrates and oxalates were developed using modified bulk method of selection from segregating population of the crosses IIHR-4 x IIHR-70 and IIHR-7 x IIHR-30. Arka Samraksha is a high-yielding (10.9 t/ha in 30-35 days), pulling-type variety with green leaves and stem, antioxidant activity of 499mg (AEAC units) and minimum nitrate content of 27.3 mg and 1.34 g oxalates per 100 g fresh leaf weight. Arka Varna also a pulling type, high-yielding variety (10.6 t/ha in 30-35 days) with green leaves and a pink stem, high antioxidant activity of 417 mg (AEAC units), low nitrate content of 37.6 mg and 1.42 g oxalates per 100 g fresh leaf weight.

Key words: Amaranth, antioxidant activity, nitrates, oxalate

Amaranth (*Amaranthus tricolor* L.) is one of the important leafy vegetables grown throughout the country. From a nutritional point of view, it enjoys a competitive rank among vegetables, being a very good source of vitamins like Vitamin A (carotene), Vitamin C, folic acid, riboflavin, thiamine and minerals like iron and calcium. These phytochemicals act as powerful antioxidants protecting cells and organs from damage caused by free-radicals and neutralizing their damaging effects. ICMR recommends a daily intake of 400g of vegetables /day/ adult, which comprises 125g of leaf vegetables (Anon., 2009). Regular consumption of these leafy vegetables can substantially improve the health of our population.

Nitrates and oxalates present in leafy vegetables in our nutrition for concern. While nitrates may get converted into potential carcinogens like nitrosamines, oxalates can form calcium oxalate (kidney stones). Although levels of oxalates and nitrates present in amaranth do not pose a serious nutritional problem under normal consumption habit, lines that have lower levels of these chemicals are certainly desirable (Ara Der Marerosian *et al*, 1979). Amaranth improvement in India has been focussed on developing high-

yielding varieties, and very limited research work has been done on nutritional improvement (Varalakshmi *et al*, 1998, 2001). Therefore, at IIHR, research efforts aimed at developing high-yielding amaranth varieties possessing high antioxidant activity with low nitrate and oxalate content resulted in the present amaranth varieties, Arka Samraksha and Arka Varna. Characteristic features and nutritional composition of these two varieties are given in Tables 1 and 2. Arka Varna recorded maximum content of potassium (918mg%), calcium (471.2g%) and magnesium (201.8mg%), whereas Arka Samraksha recorded maximum iron (11mg%) and zinc (0.63g%) content.

Salient features of Arka Samraksha' and Arka Varna':

Arka Samraksha: This variety was developed by modified bulk method of selection from segregating population of the cross IIHR-4 x IIHR-70, in F₆ generation: High-yielding amaranth variety with high antioxidant activity of 499mg (AEAC units) and minimum nitrate content (27.3mg) and 1.34g oxalates per 100g fresh weight of leaves. It is a pulling type amaranth with green leaves and stem; yields 10.9t/ha in 30-35 days.

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Arka Samraksha

Arka Varna: This was developed by the modified bulk method of selection from segregating population of the cross IIHR-7 x IIHR-30, in F₆ generation. It is a high-yielding amaranth variety, with high antioxidant activity of 417mg (AEAC units), nitrate content of 37.6mg and 1.42g of oxalates per 100g fresh weight of leaves. It is a pulling type amaranth variety with green leaves and pink stem, yields 10.6 t/ha in 30-35 days.



Arka Varna

Performance of 'Arka Samraksha' and 'Arka Varna' at IIHR, Bangalore: Arka Samraksha is a green-leaved pulling type amaranth line which was tested for its yield, antioxidant capacity, nitrate and oxalate content for three years (from 2008 to 2010) at IIHR Experimental Farm, Hessaraghatta. Average fresh-greens yield of Arka Samraksha was 10.91t/ha by pulling, 30-35 days after sowing and, increase over the check variety, Arka Suguna, was 41.8% and over the Local Check 77.4%. It recorded maximum antioxidant activity of 499mg (AEAC units) and minimum nitrate content of 27.3mg, and 1.34g of oxalates per 100g fresh weight of leaves. It also recorded 4.0% leaf protein. Average fresh-greens yield of Arka Varna was 10.58t/ha by pulling in 30-35 days after sowing, and the

Table 1. Characteristic features of amaranth varieties Arka Samraksha and Arka Varna

| Trait | Arka Samraksha | Arka Varna | Arka Suguna Check | Local Check |
|--|----------------|------------|-------------------|-------------|
| Leaf color | Green | Green | Green | Green |
| Stem color | Green | Pink | Green | Green |
| Petiole color | Green | Pink | Green | Green |
| Leaf shape | Lanceolate | Ovate | Ovate | Ovate |
| Days to 50% flowering | 40.0 | 40.8 | 40.0 | 35.0 |
| Plant height (cm) | 36.1 | 38.2 | 28.4 | 25.6 |
| Branch number | 8.2 | 8.1 | 7.3 | 7.3 |
| Leaf number | 57.8 | 50.0 | 41.2 | 44.6 |
| Leaf weight (g) | 61.3 | 59.2 | 56.7 | 38.9 |
| Stem weight (g) | 89.2 | 89.8 | 48.3 | 55.9 |
| Total plant weight(g) | 161.3 | 154.1 | 115.1 | 92.2 |
| Yield in t/ha | 10.9 | 10.6 | 7.69 | 6.15 |
| Antioxidant activity (mg/100g fresh wt.) | 499 | 417 | 419.6 | 389.2 |
| Nitrate content (mg/100g fresh wt.) | 27.3 | 38.2 | 65.8 | 82.4 |
| Oxalate content (mg/100g fresh wt.) | 1.34 | 1.42 | 1.61 | 1.42 |

Table 2. Nutritional composition of amaranth varieties Arka Samraksha and Arka Varna

| Nutritional component | Arka Samraksha | Arka Varna | Arka Suguna Check | Local Check |
|-----------------------|----------------|------------|-------------------|-------------|
| Moisture (%) | 86.1 | 86.5 | 87.3 | 86.8 |
| Protein (%) | 4.0 | 4.1 | 3.4 | 3.5 |
| P (mg%) | 50.9 | 61.0 | 44.0 | 50.9 |
| K (mg%) | 715.9 | 918.0 | 717.6 | 627.0 |
| Ca (mg%) | 463.6 | 471.2 | 357.5 | 420.4 |
| Mg (mg%) | 199.5 | 201.8 | 182.9 | 179.5 |
| S (mg%) | 60.4 | 50.2 | 42.2 | 54.1 |
| Fe (mg%) | 11.1 | 6.2 | 11.5 | 9.0 |
| Mn (mg%) | 0.67 | 0.71 | 0.52 | 0.62 |
| Zn (mg%) | 0.63 | 0.61 | 0.53 | 0.59 |
| Cu (mg%) | 0.18 | 0.16 | 0.14 | 0.13 |

increase over check variety, Arka Suguna, was 37.6%, and over the Local Check 72.0%. It recorded antioxidant activity of 417mg (AEAC units), nitrate content of 38.2mg and 1.42g of oxalates per 100g fresh weight of leaves. Further, it has recorded 4.1% of leaf protein (Table 3).

Performance at different locations: The two varieties were tested at Central Horticultural Experiment Stations of IIHR at Bhubaneswar, and at Hirehalli, for yield and quality during rainy season (June-July) of the year 2009 (Table 4).

At Central Horticultural Experiment Station, Bhubaneswar, 'Arka Samraksha' recorded fresh-greens yield of 13.9t/ha by pulling, which was superior to the Checks 'Arka Suguna' (8.54t/ha) and 'Local' variety (8.75t/ha). It recorded antioxidant capacity of 315.2mg (AEAC units)

Table 3. Mean performance of amaranth varieties Arka Samraksha and Arka Varna for total yield, antioxidant activity, nitrate and oxalate content during 2008-2010 at IIHR, Bangalore

| Variety | Total plant weight (g) | Yield kg/plot (4m ²) | Yield (t/ha) | Antioxidant activity mg (AEAC units/ 100g fresh wt.) | Nitrates (mg/100g fr. leaf wt.) | Oxalates/100g fr. leaf wt. |
|------------------------|------------------------|----------------------------------|--------------|--|----------------------------------|----------------------------|
| Arka Samraksha | 161.3 | 4.36 | 10.91 | 499.0 | 27.3 | 1.34 |
| Arka Varna | 154.1 | 4.23 | 10.58 | 417.0 | 38.2 | 1.42 |
| Arka Suguna (c) | 115.1 | 3.08 | 7.69 | 419.6 | 65.8 | 1.61 |
| Local Check | 92.2 | 2.46 | 6.15 | 389.2 | 82.4 | 1.42 |
| Mean | 133.2 | 3.55 | 8.87 | 428.8 | 58.2 | 1.65 |
| C.D. (<i>P</i> =0.01) | 47.5 | 1.27 | 3.17 | 39.7 | 15.6 | 0.13 |
| CV (%) | 8.6 | 8.05 | 9.08 | 15.7 | 13.6 | 13.4 |

Table 4. Performance of amaranth varieties Arka Samraksha and Arka Varna for quantitative / qualitative traits during Kharif 2009 at CHES, Bhubaneswar and Hirehalli

| Variety | CHES, Bhubaneswar | | | CHES, Hirehalli | | | |
|------------------------|-------------------|--|-----------------------------------|-----------------|---|----------------------------------|------------------------------|
| | Yield (t/ha) | Antioxidant activity (mg AEAC units / 100g fr. leaf wt.) | Nitrates (mg / 100g fr. leaf wt.) | Yield (t/ha) | Antioxidant activity (mg AEAC units/ 100g fr. leaf wt.) | Nitrates (mg/ 100g fr. leaf wt.) | Oxalates (100g fr. leaf wt.) |
| Arka Samraksha | 13.87 | 315.2 | 29.9 | 7.56 | 520.6 | 34.2 | 1.2 |
| Arka Varna | 9.47 | 214.0 | 27.9 | 6.67 | 596.4 | 15.0 | 1.2 |
| Arka Suguna (c) | 8.54 | 99.2 | 172.6 | 4.31 | 399.1 | 40.3 | 1.1 |
| Local check | 8.75 | 183.2 | 88.2 | 4.11 | 433.4 | 64.9 | 1.2 |
| Mean | 11.69 | 190.9 | 73.7 | 5.5 | 474.4 | 67.4 | 1.2 |
| C.D. (<i>P</i> =0.05) | 6.08 | 36.3 | 31.7 | 1.41 | 42.1 | 15.6 | 0.052 |
| CV (%) | 13.3 | 15.3 | 19.2 | 6.6 | 15.3 | 14.2 | 7.3 |

and 29.9mg nitrates per 100g of fresh weight of leaves. At CHES, Hirehalli, by pulling, it recorded 7.56t/ha, which was significantly higher than in the Check, Arka Suguna (4.31t/ha) and 'Local' variety (4.11t/ha). It recorded antioxidant activity of 520.6mg (AEAC units), 34.2mg nitrates and 1.22g of oxalates per 100g fresh weight of leaves.

'Arka Varna' at Bhubaneswar recorded fresh-greens yield of 9.47t/ha by pulling, which is superior to the checks 'Arka Suguna' (8.54t/ha) and 'Local variety' (8.75t/ha). It recorded an antioxidant capacity of 214mg (AEAC units) and 27.9mg nitrates per 100g fresh weight of leaves. At Hirehalli, by pulling it recorded 6.67t/ha, which was significantly higher than in the checks, 'Arka Suguna' (4.31t/ha) and 'Local variety' (4.11t/ha). It recorded antioxidant capacity of 596.4mg (AEAC units), 15.0mg nitrates and 1.22g oxalates per 100g fresh weight of leaves at Hirehalli.

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