

Nutrient Composition of Some New Varieties of Finger Millet (*Eleusine coracana*)

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Abstract

*Nutritional security of vulnerable sections of our society namely, the rural women and children needs to be ensured in order to develop better human resources. Finger millet (*Eleusine Coracana*), being highly nutritious can augment for providing nutritional security. So sixteen varieties of finger millet were analysed for their nutrient composition including minerals and antinutritional factors. Among them, the variety 'VL-204' was found to be exceptionally rich in crude protein (15.58 percent), iron (5.42 percent) and very low in antinutritional factor phytate content (142.65 mg per cent). Another variety VL-326 was high in calcium (720 mg percent). The results revealed that all the sixteen finger millet varieties have good nutritive value and can be used in supplementary feeding to ensure nutritional security of our rural masses.*

The finger millet (*Eleusine coracana*) is an important staple food grain in central and southern parts of India including the foothills of Northern Himalayas especially Uttaranchal. Finger millet grain is highly nutritious, being rich in protein, fat and minerals, especially calcium and iron. It is non acid forming food and easy to digest. It is considered to be one of the least allergic and most digestible grains available and it helps to heat the body in cold and rainy season (Railey, 2000).

A number of high yielding varieties of finger millet have now been identified and introduced for general cultivation. The present investigation was undertaken to identify promising finger millet varieties with better nutritional qualities.

METHODOLOGY

Grain samples of 16 varieties of finger millet were obtained from Vivekanda Parvatiya Krishi Anusandhan shala (Almora, Uttaranchal). The samples were cleaned to remove grit and dust adherent to the grains was washed. The samples were sun dried and ground in electric grinder and passed through 40 mesh sieve.

The proximate composition, calcium was determined by AOAC (1995), phosphorous by colorimetric method (Ranganna, 1986), copper, magnesium and zinc by atomic absorption spectrophotometric method (Raghuramulu *et al.*, 2003). All the estimations were done in triplicate and the data has been presented as means of three readings \pm SD.

RESULTS AND DISCUSSION

Proximate composition of nutrients, minerals and composition of antinutritional factors were analysed.

Proximate Nutrient Composition

The proximate composition of all the sixteen varieties is shown in Table 1

Moisture : The moisture content of the finger millet varieties ranged from 7.20 ('VL-323') to 9.82 percent ('RAU-8') with a mean value of 8.51' percent. Two varieties viz. 'PR-202' and 'RAU-8' had significantly higher ($p < 0.05$) moisture content than the mean value. Rao *et al.* (1973) reported the moisture content of finger millet grains in the range of 4.95 to 7.80 percent while Singh *et al.* (2003); Gopalan *et al.* (1999) and Babut *et*

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Table 1: Proximate composition of finger millet varieties

Variety	Moisture (%)	Crude Protein (%)	Crude fat (%)	Crude fibre (%)	Total ash (%)	Carbohydrate (%)	Physiological energy (K cal / 100g)
HR-374	8.57±0.72 ^{c,d,a}	12.83±0.50 ⁱ	1.00±0.50	3.15±0.16 ^{b,c,d}	2.18±0.07 ^e	72.27±0.12 ^c	349±1.57 ^{c,d}
VL-328	7.43±0.49 ^{ab}	11.07±0.25 ^g	1.74±0.16	4.27±0.34 ^{h,i}	1.94±0.12 ^{b,c,d}	73.55±0.76 ^d	354±0.92 ^d
VL-322	8.19±1.33 ^{b,c}	7.91±0.72 ^{d,e}	0.76±0.50	3.44±0.29 ^{d,e,f}	2.08±0.20 ^{d,e}	77.62±0.28 ^f	349±0.76 ^{c,d}
PR-202	9.80±0.19 ^f	11.07±0.25 ^g	1.20±0.28	3.04±0.60 ^{b,c}	2.37±0.08 ^f	72.52±0.57 ^c	345±0.89 ^{b,c}
VL-204	8.29±0.90 ^{c,d}	15.58±0.06 ^f	1.48±0.23	4.00±0.19 ^{g,h}	2.54±0.09 ^g	68.11±0.50 ^a	348±0.58 ^{b,c,d}
RAU-8	9.82±0.24 ^f	11.81±0.00 ^h	1.48±0.17	4.35±0.28 ^{ij}	2.44±0.01 ^g	70.10±0.46 ^b	341±1.27 ^b
VL-329	8.87±0.54 ^{c,d,e}	8.75±0.00 ^f	1.38±0.14	4.65±0.26 ^j	1.94±0.01 ^{b,c,d}	74.41±0.33 ^d	350±0.46 ^{c,d}
VR-708	9.13±0.15 ^{e,f}	8.75±0.00 ^f	1.88±0.16	4.10±0.20 ^{h,i}	2.03±0.14 ^{c,d,e}	74.11±0.36 ^d	349±0.97 ^{c,d}
VL-149	8.84±0.30 ^{c,d,e}	8.16±0.50 ^{d,e}	1.58±0.15	3.64±0.50 ^{c,f}	1.90±0.10 ^{b,c}	75.88±0.92 ^e	320±0.98 ^a
VL-327	9.05±0.99 ^{d,e,f}	5.83±0.10 ^b	1.78±0.14	2.43±0.15 ^a	1.88±0.36 ^{b,c}	79.03±0.48 ^{g,h}	355±0.89 ^d
PES-400	7.46±0.84 ^{ab}	8.45±0.50 ^{e,f}	1.15±0.13	3.73±0.66 ^{f,g}	2.58±0.15 ^g	76.63±0.33 ^e	352±0.92 ^{c,d}
VL-315	8.06±0.45 ^{b,c}	13.25±0.25 ^{ij}	1.40±0.50	2.98±0.66 ^b	2.45±0.00 ^g	71.86±0.28 ^c	353±1.38 ^d
VL-326	8.88±0.91 ^{c,d,e}	7.87±0.00 ^d	1.01±0.13	3.02±0.20 ^{b,c}	1.47±0.16 ^a	77.75±0.15 ^f	352±0.89 ^{c,d}
VL-324	8.25±0.63 ^{b,c,d}	7.14±0.50 ^e	1.44±0.23	3.32±0.33 ^{c,d,e}	1.78±0.07 ^b	78.07±0.46 ^{f,g}	354±0.90 ^d
VL-323	7.20±0.17 ^a	12.25±0.00 ^h	0.98±0.13	3.45±0.50 ^{d,e,f}	2.11±0.12	74.01±0.52 ^d	354±0.88 ^d
VL-146	8.26±0.91 ^{b,c,d}	4.88±0.27 ^a	1.32±0.20	3.52±0.42 ^{e,f}	2.11±0.11	79.91±0.50 ^h	351±0.64 ^{c,d}
Mean	8.51	9.27	.018	3.56	2.11	74.73	348.51
CD at 5%	0.837	0.563	0.124	0.323	0.160	0.970	7.866

al. (1987) reported the moisture content in the range of 10.2-13.0 percent. Variation in grain moisture of different genotypes may be attributed to the physico-chemical qualities of the grain due to genetic variation.

Crude protein: Crude protein in finger millet reported by several authors is based on nitrogen estimation by *Kjeldhal technique* and its conversion to protein using a multiplication factor of 6.25. The protein content in the present study ranged from 4.88 percent ('VL-146') to 15.58 percent ('VL-204') with a mean value of 9.728 percent. Seven varieties 'RAU-8', 'VL-315', 'VL-323', 'HR-374', 'VL-204', 'VL-328', 'PR-202' had significantly higher ($p < 0.05$) protein content than the mean value. Vadivoo *et al.* (1998) reported the protein content of finger millet in the range of 6.68 to 12.34 percent while Rao *et al.* (1973) reported it in the range

of 4.71 to 9.88 percent. The results on protein content in finger millet varieties are in accordance with the protein content reported in literature except for the varieties 'VL-315', 'HR-374' and 'VL-204'. The variation in protein content of the finger millet varieties might be due to genetic factors, time and amount of application of nitrogen fertilizer (Lupien, 1990).

Crude fat: The crude fat also designated as ether extract ranged from 0.76 ('VL-322') to 1.88 percent ('VR-708') with a mean value of 1.34 percent. Nine varieties viz. 'VL-327', 'VL-315', 'VL-324', 'VL-149', 'VR-708', 'RAU-8', 'VL-328', 'VL-329' and 'VL-204' had significantly higher ($p < 0.05$) crude fat content than the mean value. Earlier studies revealed that the crude fat content of finger millet has been in the range of 1.3-1.8 percent (Bhatt *et al.*, 2003; Singh *et al.*, 2003; Malleshi and Desikachar, 1986; Lupien, 1990). The variation in

fat content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and environment prevailing in growing region (Lupien, 1990).

Crude Fibre :In the present study the crude fibre content ranged from 2.43 percent ('VL-327') to 4.65 percent ('VL-329') with a mean value of 3.56 percent. Five varieties viz 'VR-708', 'RAU-8', 'VL-329', 'VL-204' and 'VL-328' had significantly ($p < 0.05$) higher crude fiber content than the mean value. Kamath and Belavady (1980) found 3.6 percent crude fibre in finger millet. Joshi and Katoch (1990) reported 3.7 percent crude fibre in finger millet. The variation in crude fibre content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and environmental factors (Lupien, 1990).

Total ash: The total ash consists of inorganic constituents, which refer to the residue that remain after the organic matter has been burned away. The total ash content of the sixteen varieties under the present investigation ranged from 1.47 ('VL-326') to 2.58 percent ('PES-400') with a mean value of 2.11 percent. Five varieties viz. 'PR-202', 'RAU-8', 'PES-400', 'VL-204' and 'VL-315' had significantly higher ($p < 0.05$) total ash content than the mean value. The ash content has been found to be 1.7 percent (Rao, 1994) to 4.13 percent (Rao *et al.*, 1973) in finger millet. The result of total ash content in finger millet varieties are in accordance with the total ash content reported in literature.

Carbohydrates by difference :The carbohydrate content ranged from 68.11 percent ('VL-204') to 79.91 percent ('VL-146') with a mean value of 74.73 percent. Six varieties viz. 'VL-322', 'VL-327', Gopalan *et al.* (2000) reported energy content of finger millet grain as 328 Kcal / 100 g. The variation in energy content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and environmental factors. (Lupien, 1990).

Physiological energy value :The physiological energy content ranged from 320 Kcal / 100 g ('VL-149') to 355 Kcal / 100 g ('VL-327') with a mean value of 349

Kcal / 100 g. Twelve varieties viz. 'HR-374', 'VL-328', 'VL-322', 'VL-329', 'VR-708', 'VL-315', 'VL-327', 'PES-400', 'VL-146', 'VL-323', 'VL-326' and 'VL-324' had higher energy content than the mean value. The difference between the mean value and physiological energy value was statistically non significant ($p > 0.05$). Gopalan *et al.* (2000) reported energy content of finger millet grain as 328 Kcal / 100 g. The variation in energy content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and environmental factors. (Lupien, 1990).

Mineral composition :Mineral analysis included the estimation of calcium, phosphorus, iron, copper, zinc and magnesium. The mineral composition of all the sixteen varieties has been shown in Table 2

Iron : The iron content ranged from 3.61 mg / 100 g ('VL-327') to 5.42 mg percent ('VL-204') with a mean value of 4.40 mg / 100 g. Two varieties viz. 'VL-326' and 'VL-204' had higher iron content than the mean value. In literature the iron content of finger millet varieties has been reported to range from 3.3-14.8 mg percent (Babu *et al.*, 1987; Lestienne *et al.*, 2005). The results on iron content in finger millet varieties are comparable with the iron content reported in literature.

Copper : The copper content of the sixteen varieties ranged from 0.25 mg percent ('VL-323') to 0.60 mg percent ('VL-204') with a mean value of 0.39 mg percent. Nine varieties viz. 'VL-326', 'VL-322', 'VL-328', 'VL-204', 'VR-708', 'VL-146', 'HR-374', 'RAU-8' and 'VL-324' had higher copper content than the mean value but the non significant differences ($p > 0.05$) were observed between the copper content of nine varieties and the mean value. Lupien (1990) has reported the copper content of finger millet as 0.47 mg percent. The variation in copper content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and environmental factors such as sunlight, temperature prevailing in growing region, water and soil composition (Harris, 1975)

Zinc: It is observed that the zinc content of the sixteen varieties under this investigation ranged from 0.92 mg percent ('VL-327') to 2.55 mg percent ('VL-204') with

Table 2: Mineral composition of finger millet varieties

Variety	Iron (mg/100g)	Copper (mg/100g)	Zinc (mg/100g)	Magnesium (mg/100g)	Calcium (mg/100g)	Phosphorous (mg/100g)
HR-374	4.45±0.04 ^{bc}	0.41±0.06 ^{ab}	1.37±0.10 ^a	65.32±0.11 ^e	200±1.9 ^a	190±0.94 ^f
VL-328	4.15±0.04 ^{ab}	0.40±0.08 ^{ab}	1.14±0.20 ^a	64.01±0.13 ^{bc}	580±2.5 ^b	157±0.61 ^{bc}
VL-322	4.55±0.04 ^{bc}	0.58±0.03 ^{ab}	1.53±0.14 ^a	64.08±0.16 ^{bc}	600±2.4 ⁱ	165±0.98 ^{de}
PR-202	4.54±0.06 ^{bc}	0.35±0.11 ^{ab}	1.54±0.16 ^a	64.49±0.20 ^{cd}	510±2.5 ^f	165±1.0 ^{de}
VL-204	5.42±0.03 ^c	0.60±0.07 ^b	2.55±0.08 ^b	65.40±0.14 ^e	400±2.0 ^d	250±0.95 ^h
RAU-8	4.38±0.03 ^{bc}	0.43±0.03 ^{ab}	1.42±0.09 ^a	63.24±0.16 ^a	540±1.9 ^g	295±0.95 ⁱ
VL-329	4.16±0.05 ^{ab}	0.32±0.07 ^{ab}	1.05±0.10 ^a	63.22±0.10 ^a	520±1.8 ^{fg}	160±1.0 ^{cd}
VR-708	4.28±0.03 ^{abc}	0.50±0.09 ^{ab}	1.22±0.14 ^a	63.84±0.09 ^{abc}	450±1.9 ^e	180±0.97 ^{ef}
VL-149	4.21±0.06 ^{ab}	0.31±0.02 ^{ab}	1.14±0.11 ^a	65.29±0.13 ^e	360±2.0 ^c	170±0.88 ^{de}
VL-327	3.61±0.02 ^a	0.29±0.03 ^{ab}	0.92±0.12 ^a	63.39±0.24 ^{ab}	400±1.8 ^d	143±0.97 ^{ab}
PES-400	4.50±0.04 ^{bc}	0.31±0.05 ^{ab}	1.34±0.11 ^a	65.56±0.20 ^e	400±1.8 ^d	215±0.90 ^g
VL-315	4.39±0.02 ^{bc}	0.26±0.02 ^a	1.20±0.20 ^a	63.77±0.11 ^{ab}	350±2.0 ^c	130±0.97 ^a
VL-326	4.83±0.02 ^c	0.45±0.03 ^{ab}	1.04±0.08 ^a	65.15±0.22 ^{de}	720±2.0 ^j	157±1.0 ^{bc}
VL-324	4.25±0.05 ^{abc}	0.39±0.02 ^{ab}	1.22±0.09 ^a	63.98±0.12 ^{bc}	450±2.4 ^e	180±0.90 ^{ef}
VL-323	4.11±0.02 ^{ab}	0.25±0.09 ^a	1.16±0.12 ^a	63.60±0.18 ^{ab}	280±1.9 ^b	195±1.0 ^f
VL-146	4.57±0.05 ^{bc}	0.42±0.07 ^{ab}	1.64±0.08 ^{ab}	64.50±0.15 ^{cd}	580±1.8 ^h	135±0.94 ^a
Mean	4.40	0.39	1.34	64.30	458.75	180.43
CD at 5 %	0.197	0.324	0.926	0.690	24.775	17.050

a mean value of 1.34 mg percent. Seven varieties 'VL-322', 'VL-204', 'VL-146', 'PES-400', 'HR-374', 'RAU-8' and 'PR-202' had higher zinc content than the mean value but the differences were statistically non significant at 5% level of significance. Lupien (1990) has reported the zinc content of finger millet as 2.3 mg percent. The variation in zinc content of the finger millet grains in the present study and that in reported literature might be due to genetic factors and variation in zinc content, pH of the soil, zinc content of the water in growing region (Brandy, 2001).

Magnesium : The magnesium content ranged from 63.22 mg percent ('VL-329') to 65.56 mg percent ('PES-400') with a mean value of 64.30 mg percent. Five varieties viz. 'VL-326', 'VL-204', 'VL-146', 'PES-400' and 'HR-374' had significantly higher ($p < 0.05$) magnesium content than the mean value. Lupien (1990) has reported the magnesium content of finger millet as 137.0 mg percent. The variation in magnesium content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and

micronutrient content of the soil in growing region (Lupien, 1990).

Calcium : Finger millet is rich in calcium. The calcium content of the varieties ranged from 200 mg percent ('HR-374') to 720 mg percent ('VL-326') with a mean value of 458.75 mg percent. Seven varieties viz. 'VL-326', 'VL-322', 'VL-329', 'VL-328', 'VL-146', 'RAU-8' and 'PR-202' had higher calcium content than the mean value. Vadivoo *et al.*, (1998) has reported the calcium content in the range of 162-487 mg percent while Rao *et al.*, (1973) reported it in the range of 203.10-657 mg percent. The results of calcium content in finger millet varieties are in accordance with calcium content reported in the two studies except for 'VL-326'. This can be due to genetic factors (Lupien, 1990).

Phosphorus : The phosphorous content ranged from 130 mg percent ('VL-315') to 295 mg percent ('RAU-8') with a mean value of 180.43 mg percent. Five varieties viz. 'VL-214', 'VL-323', 'PES-400', 'HR-374' and 'RAU-8' had higher phosphorus content than

the mean value. Rao (1994) reported the phosphorus content of finger millet in the range of 197-202 mg percent. Antony and Chandra (1998) reported a high value of phosphorus (467.2 mg percent) in finger millet while Babu *et al.*, (1987) reported low values of phosphorus in finger millet (25-30.8 mg percent). The variation in phosphorus content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors, soil phosphorus content, pH of the soil, time and type of the fertilizer applied and method of application of fertilizer (Brandy, 2001).

Antinutritional factors : The antinutritional factors namely tannins and phytates were estimated in the varieties. Tannins are known to be potent inhibitors of iron absorption and interfere with bioavailability of iron (Rao and Prabhavati, 1982). Phytates chelate dietary minerals in gastrointestinal tract reducing their bioaccessibility and bioavailability. The antinutrient content of the varieties has been shown in Table 3.

Table 3: Antinutrient content of the varieties

Name of Variety	Tannin (mg / 100g)	Phytates (mg / 100g)
HR-374	174.94±13.50 ^a	164.76±3.81 ^{c,df}
VL-328	218.66±14.97 ^a	146.45±5.68 ^{ab}
VL-322	57.32±20.75 ^b	154.75±7.24 ^{a,b,c,d}
PR-202	129.51±18.34 ^f	156.38±7.82 ^{b,c,d}
VL-204	161.06±24.31 ^b	142.65±3.43 ^{ab}
RAU-8	208.03±16.59 ^j	170.16±5.76 ^f
VL-329	206.32±18.48 ^{ij}	168.45±3.24 ^{df}
VR-708	98.17±19.95 ^d	164.36±7.48 ^{c,df}
VL-149	56.00±11.99 ^b	154.44±6.00 ^{a,b,c}
VL-327	203.81±12.44 ⁱ	162.22±2.17 ^{c,df}
PES-400	127.65±16.57 ^f	166.72±6.13 ^{df}
VL-315	123.75±14.86 ^f	148.36±4.24 ^{ab}
VL-326	147.24±24.37 ^b	148.50±6.42 ^{ab}
VL-324	40.22±10.12 ^a	164.25±5.76 ^{c,df}
VL-323	84.18±13.57 ^c	168.36±2.82 ^{df}
VL-146	108.56±26.94 ^e	152.78±8.20 ^{a,b,c}
Mean	134.08	158.34
CD at 5 percent	13.601	12.265

Means followed by different letters in a column differ significantly at 5% level of significance.

Tannins : The tannin content of the sixteen varieties has been observed in range from 40.229 mg percent ('VL-324') to 218.66 mg percent ('VL-328') with a mean value of 134.08 mg percent. Six varieties viz. 'VL-204', 'VL-327', 'VL-328', 'VL-329', 'HR-374' and 'RAU-8' had significantly higher ($p < 0.05$) tannin content than the mean value. Rao and Prabhavati (1982) have reported 360 mg percent tannins in brown finger millet while Rao (1994) reported higher values of 2392 mg / 100 g in finger millet flour. The variation in tannin content of the finger millet varieties observed in the present study and that in reported literature is attributed to genetic factors and environment prevailing in growing region (Lupien, 1990).

Phytates : The phytate content ranged from 142.65 mg percent ('VL-204') to 170.16 mg percent ('RAU-8') with a mean value of 158.34 mg percent. Eight varieties viz. 'VL-327', 'VR-708', 'VL-329', 'HR-374', 'RAU-8', 'VL-323', 'PES-400' and 'VL-324' had higher phytate content than the mean value but the differences were statistically non significant ($p > 0.05$). Rao (1994) reported phytate content to be 149 to 150 mg percent in finger millet while Antony and Chandra (1999) reported higher phytin phosphorous of 679 to 693 mg percent of finger millet. The variation in phytate content of the finger millet varieties in the present study and that in reported literature might be due to genetic factors and growing environment of the crop (Lupien, 1990).

The analysis of sixteen varieties revealed that all the varieties have good nutritive value. The variety 'VL-204' is exceptionally rich in protein (15.58 percent), variety 'VL-326' is exceptionally rich in calcium (720 mg percent) and variety 'VL-204' is rich in iron (5.42 mg percent). These varieties can be successfully used in developing calcium and iron rich food products, which can be further used in supplementary feeding programmes to combat the problems of calcium and iron deficiency.

CONCLUSION

The sixteen varieties analysed have high nutritive value and can be successfully used for formulating nutritious food items. These food items can be used for supplementary feeding. The varieties of finger millet analyzed for nutritive value were found to be useful for supplementary feeding. Not only the food security in terms of access and availability is important from the point of view of a healthy population, but extremely important is to provide nutritional security to our masses. In this context, finger millet inclusion in our daily diets can provide nutritional security to our rural masses.

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