RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume 56 Issue 1: 1-6 (February 2022)

Analysis of Nutritional Diversity and Antioxidant Activity of Finger Millet Landraces

T.S. Kazi[1], S.L. Laware[2], S.G. Auti[1]

10.18805/IJARe.A-5741

ABSTRACT

Background: Finger millet landraces exhibit great diversity as it grown in wide range of climatic conditions. Landraces keep huge nutritional and antioxidant potential but it has been highly ignored during the course of time. Exploration of landraces are essential to find out potential landraces on the backdrop of malnutrition in tribal pockets and nutrient deficiency in urban region.

Methods: Finger millet landraces were collected from tribal pockets of Nashik, Ahmednagar, Dhule and Kolhapur districts of Maharashtra, India. Nutritional and antioxidant studies were done by following standard protocols.

Result: Obtained results shows nutritional diversity and exhibit good amount of antioxidant activity. Landraces exhibited significant amount of protein (3.55% to 18.20%), carbohydrates (40% to 78.33%) and reducing sugars (149.67 mg/100 gm to 666 mg/100 gm), while vitamin C content did not show variations. Difference in the tannin content of red-brown (7444.67 mg/100 gm) and white grains (1347 mg/100 gm) was noted. Variation in the phenolic, flavonoids contents and antioxidant activity were noted. The highest antioxidant activity was noted during the investigation (84.95%, 81.41% and 80.53%). To conclude, finger millet landraces are highly nutritious and need to be conserve as potential source of nutrients and antioxidant and for nutritional traits.

Key words: Antioxidant activity, Finger millet landraces, Nutritional diversity.

INTRODUCTION

Finger millet [*Eleusine coracana* (L.) Gaertn.] is one of the most important millet grown in India and Africa. In India. *Eleusine coracana*. Most of the farmers, specifically from hilly regions are using conventional seeds for cultivation (landraces) other than varieties releases by Agricultural Universities. As these landraces are region specific, exhibit variation in their morphological and nutritional attributes. In most of the parts, these landraces perform better over to varieties in terms of nutritional components. Despite of this, these landraces have not been explored for its nutritional and antioxidant potential.

Finger millet has gained importance because of a higher amount of calcium (344 mg/100 gm), iron 3.9 mg% (Gopalan *et al.,* 2009), phenolic compounds and antioxidant activity (Geetha *et al.,*1990) and of its functional components, such as slowly digestible starch (Wadikar *et al*., 2007), protein (5-8%), carbohydrates (65-75%), dietary fiber (15-20%) and minerals (2.5-3.5%) (Chethan and Malleshi, 2007). As of now, it is the richest and cheapest source of calcium and iron for all people, specifically; people reside in the hilly regions.

The high levels of polyphenols in millets are identified to play an important role in lowering the rate of fat absorption and slow release of sugars (low glycemic index) thereby reducing the risk of heart disease, diabetes and high blood pressure (Kumar *et al*., 2018). It is now established that phytates, polyphenols and tannins can contribute to the antioxidant activity of the millet foods, which is an important factor in health, aging and metabolic diseases (Bravo 1998).

[1]Department of Botany, H.P.T. Arts and R.Y.K. Science College, Nashik-422 005, Maharashtra, India.
[2]Arts, Commerce and Science College, Sonai, Tal-Newasa, Ahmednagar-414 105, Maharashtra, India.

Corresponding Author: S.G. Auti, Department of Botany, H.P.T. Arts, R.Y.K. Science College, Nashik-422 005, Maharashtra, India. Email: autisanjay66@gmail.com

How to cite this article: Kazi, T.S., Laware, S.L. and Auti, S.G. (2022). Analysis of Nutritional Diversity and Antioxidant Activity of Finger Millet Landraces. Indian Journal of Agricultural Research. 56(1): 1-6. DOI: 10.18805/IJARe.A-5741.

Submitted: 22-01-2021 **Accepted:** 27-04-2021 **Online:** 27-05-2021

The finger millet grain are rich in polyphenols compared to many other continental cereals (Viswanath *et al*., 2009).

On this backdrop, exploration of landraces are indispensable for the conservation of nutritionally rich landraces and as a source of nutritional traits for crop improvement programme.

MATERIALS AND METHODS

Germplasm collection

Sixty-four finger millet landraces *were* collected from Nashik, Ahmednagar, Dhule and Kolhapur districts of Maharashtra, India. The accession numbers were given to the collected landraces from T1 to T64. To identify potential landraces, morphological studies has been carried out (Auti *et al.,* 2017, Kazi and Auti, 2017). Based on the morphological characters, the 33 landraces (T1-T33) have been selected

for nutritional and antioxidant studies. The Dapoli-1 variety developed by Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli, Maharastra (India) was considered as control.

Biochemical analysis

Biochemical studies were carried out by following standard procedures. Nitrogen in the samples was estimated by the standard micro-Kjeldahl procedure and multiplied by the factor 6.25 to obtain crude protein (Sahrawat *et al*., 2002). The total carbohydrates were estimated by Anthron reagent (Dreywood, 1946) and reducing sugars by the dinitrosalicylic acid method (Nelson, 1944). Ghosh *et al*., (1963) method, estimated vitamin C. The total phenols were analyzed by the Folin-Phenol reagent method as used by Farkas and Kiraly (1962) and flavonoids by aluminium chloride reagent method (Chang *et al*., 2002). Tannin was estimated by Folin-Denis method (Pearson 1976). The radical scavenging activity was determined by the DPPH assay (Blois 1958).

Statistical analysis

The triplicate data of nutritional contents were statistically analysed by IBM-SPSS 9 (Software version- v20). Data, expressed as Mean±SD was statistically analysed using one-way ANOVA was used to compare means and significance was accepted at $p>0.05$.

RESULTS AND DISCUSSION

Results of the analyses revealed that there were significant differences in the nutritional composition, phytochemicals and antioxidant activity among finger millet landraces (T1-T33) and as compared to control. Obtained results are represented in Table 1 and 2.

Nutritional composition

Protein

From the above results, it can be observed that the T1 (18.20%) contains the highest levels of protein across all the other landraces and as compared to control (7.10%).

The high content of protein ranging from 10.32% to 14.5% was exhibited by T10, T14, T15, T25, T32 and T33, demonstrating the finger millet as a significant source of proteins. Overall, the other landraces demonstrate significant yields of protein ranging from 3.55% to 9.90%.

Carbohydrates

In the case of carbohydrates, the control T (79.67 mg/100 gm) contains the highest levels of carbohydrates as compared to all the other landraces; however, significant levels of carbohydrates are demonstrated by T4, T5, T21 and T23 within the range of 70.33% to 78.33%. Moderate amount of carbohydrate from 40% to 67.3% was noted in other landraces.

Reducing sugar

Further, significant variations in the reducing sugar content were observed in the landraces. The landraces T2, T3, T12, T14, T16, T17, T18, T25, T28, T29, T30 and T32 (375 mg/100 gm to 666 mg/100 gm) showed high levels of reducing sugars as compared to control. In the rest of the landraces, the amount of reducing sugar was in the range of 144 mg/100 gm to 324 mg/100 gm.

Vitamin C

For the vitamin C content, all the samples exhibit relatively higher content of vitamin C except T7, T21, T23 and T33 when compared with control T (0.12 mg/100 gm). Also, the significantly highest content of vitamin C was shown by T2 (0.2 mg/100 gm) and T15 (0.18 mg/100 gm). Significant variations were not observed among landraces.

Phytochemical composition

Phytochemical contents along with the antioxidant activity of landraces are given in Table 2.

Total phenol content

In case of phenolic content, significant variations were noted among the landraces. In control 434.33 mg/100 gm phenolic content was noted while in finger millet landraces amount ranges from 355.33 mg/100 gm to 1617 mg/100 gm. T2 landrace being white showed less amount (355.33 mg/100 gm) while red to brown colour landraces possess high phenolic content.

Total flavonoid content

Flavonoid content showed a higher level in case of finger millet landraces as compared to control. The amount of flavonoids ranges from 24.33 mg/100 gm to 84.5 mg/100 gm, while least in control *i.e*. 6.50 mg/100 gm.

Tannin

In the case of tannins, the control shows lower levels as compared to the selected landraces, the landraces T16 and T17 show remarkably higher levels of tannins (4945.33 mg/100 gm and 7444.67 mg/100 gm) respectively. The least amount of tannin 1347 mg/100 gm was noted in the T2 (white) landrace.

Antioxidant activity

For the antioxidant potential, the majority of landraces showed significantly high antioxidant activity with T1, T2, T4, T10, T13, T14, T16, T17, T19, T20, T21, T22, T23, T24, T26, T29, T30 and T31 showing the maximum antioxidant capacity over 70%. The highest activity was noted in T1 (84.95%), T19 (81.41%) and T29 (80.53%) landraces.

Results obtained in the present study are supported by many researchers *viz*., Barbeau and Hilu (1993); Sripriya *et al.* (1997); Chetan and Malleshi (2007); Shobana *et al.* (2010); Marathe and Bhaskar (2011); Singh and Raghuvanshi, (2011) David *et al.* (2016); Katake *et al.* (2016); Udeh *et al.* (2018) and Kumar *et al.* (2018).

According to FAO, (2016) millets exhibit the presence of major nutrients containing carbohydrates (60-70%), crude fibre (2-7%), proteins (7-11%), fat (1.5-5%), vitamins and minerals. Sripriya *et al.* (1997) detailed that carbohydrate

content in finger millet is approximately 81.5%, crude fiber 4.3%, protein 9.8% and mineral 2.7% that is practically comparable to different varieties of millet. Malleshi, (2003) revealed that finger millet is a decent source of dietary sugars.

Arora *et al.* (2003) revealed that the presence of anti-nutrients in millet, like phytate, polyphenols, oxalates, affected mineral bioavailability. Dharmaraj and Malleshi (2011) reported 6-8% protein, 1-1.7% fat, 65-75% starch, 18-20% dietary fiber and 2-2.5% minerals in finger millet.

Marathe and Bhaskar, (2011) reported insoluble protein content between 3.01% to 4.00% and carbohydrate content from 41% to 50% in 11 finger millet landraces from Thane district, Maharashtra. Further, Shimelis *et al.* (2009) analyzed nine finger millet genotypes from Africa and reported protein in range from 6.26 g/100 g to 10.5 g/100 g. In the present study significantly higher amount of protein (3.55% to 18.20%), carbohydrates (40% to 78.33%) and reducing sugar (144 mg/100 gm to 666 mg/100 gm) was noted.

Varietal variations in phenolic contents were reported by Chetan and Malleshi (2007) and noted a higher level of phenolic compounds in brown variety as compared to the white variety. Both free and bound forms of phenolic acids are reported in finger millet (Rao and Murlikrishna 2002).

Siwela *et al.* (2007) reported red-colored varieties of finger millet showed more tannin may be due to pigmented testa. Considerable differences (0.19 3.37%) in the total

Table 1: Nutritional components in finger millet landraces and control.

Landraces	Protein (%)	Carbohydrates (%)	Reducing sugar (mg/100 gm)	Vitamin C (mg/100 gm)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
T	7.10±2.28	79.67±2.52	144.33±2.08	0.12±0.00
T1	18.20±1.53*	56.70±1.00	147.00±2.65	0.14±0.01
T2	9.18±2.65*	60.08±3.00	559.70±1.00*	0.20±0.01*
T3	6.80±0.58	51.10±2.65	375.00±1.00*	0.13±0.01
T4	3.55±0.93	70.33±0.58	261.00±6.89*	0.15±0.01*
T5	7.91±2.31	71.90±0.76	234.67±3.51*	0.15±0.01*
T6	6.80±0.58	56.80±1.50	298.50±4.95*	0.15±0.03*
T7	8.80±1.15*	44.33±0.58	265.00±8.66*	0.06±0.01
T8	7.44±1.15	58.17±0.76	292.00±1.02*	0.15±0.01*
T9	7.90±1.15	45.50±1.53	286.00±5.29*	0.15±0.01*
T10	11.90±1.15*	57.00±2.08	275.00±5.00*	0.13±0.01
T11	9.40±0.55*	54.00±3.04	290.33±2.52*	0.10±0.01
T12	6.06±1.06	62.33±0.58	331.67±3.51*	0.13±0.01
T13	7.92±2.21	43.83±0.76	302.00±5.29*	0.14±0.01
T14	12.80±3.69*	47.50±0.50	602.67±6.43*	0.14±0.01
T15	11.86±2.11*	52.17±0.76	300.33±2.68	0.18±0.00*
T16	5.63±2.51	42.17±0.76	417.67±7.51*	0.14±0.01
T17	9.09±0.58*	59.80±0.50	455.33±5.038	0.09±0.00
T18	4.03±2.77	58.00±0.50	666.67±4.16*	0.09±0.01
T19	5.30±1.15	54.00±0.50	255.33±1.53*	0.10±0.01
T20	5.64±1.03	45.60±0.58	316.00±5.29*	0.09±0.01
T21	5.90±1.15	78.00±3.46	237.00±2.65*	0.05±0.01
T22	8.90±2.00*	67.33±4.04	237.33±2.52*	0.10±0.01
T23	6.49±1.15	78.33±0.58	430.00±2.00*	0.05±0.01
T24	8.20±2.89*	50.00±1.61	324.67±7.57*	0.11±0.01
T25	10.32±4.93*	60.00±1.00	598.67±1.07*	0.14±0.01
T26	5.20±2.89	62.33±7.09	426.67±3.06*	0.14±0.01
T27	7.48±2.89	58.33±5.51	309.33±1.86*	0.14±0.01
T28	9.90±1.15*	54.67±4.04	510.67±2.22*	0.12±0.01
T29	9.38±1.15*	53.10±1.26	506.67±7.57*	0.14±0.01
T30	8.06±3.46*	40.00±2.00	471.33±2.31*	0.14±0.01
T31	9.40±1.15*	53.67±0.58	149.67±2.52	0.13±0.01
T32	13.03±1.27*	66.33±1.53	508.00±7.21*	0.14±0.01
T33	14.50±1.15*	40.67±4.04	300.00±2.00*	0.05±0.01

T-Control, Dapoli-1; *Significant at the 0.05 level.

a. Dunnett t-tests treat one group as a control and compare all other groups against it.

polyphenol contents among 85 Indian finger millet varieties have been reported by Shankara, (1991).

Among millets finger millets have been reported to contain high amounts of tannins ranging from 0.04 to 3.74% of catechin equivalents (Antony and Chandra, 1999). Rao and Prabhavati (1982) have reported 360 mg/100 g tannins in brown finger millet. Finger millet is the sole millet reported to have condensed tannins.

Flavonoids and tannins present in millet seed coat are multifunctional and they act as reducing agents (free radical terminators), metal chelators and singlet oxygen quenchers (Rao and Murlikrishna, 2002). Finger millet is a potent source of antioxidants and this has high radical-scavenging activity higher than that of wheat, rice and other millets. The brown or red variety of finger millet had higher activity (94%) using the DPPH method than the white variety (4%), as reported by Dykes and Rooney (2006) and Sripriya *et al.* (1997). In contrast in the present study even white landrace (T2) showed higher antioxidant activity (73.45%) using the DPPH method. This might be due to the presence of compounds other than phenolic responsible for antioxidant activity. Identification and evaluation of these components has been a subject of research.

With variation in the phenolic content, the antioxidant properties are also altered, as there exists a significant correlation between the two parameters. Kumari *et al.* (2017)

Table 2: Phytochemical composition and antioxidant activity in finger millet landraces and control.

Landraces	Phenol (mg/100 gm)	Flavonoids (mg/100 gm)	Tannin (mg/100 gm)	Antioxidant activity
	Mean±SD	Mean±SD	Mean±SD	% Inhibition
T	434.33±1.01	6.50±0.50	2276±4.16	60.80%
T1	402.30±0.90	64.00±0.58*	1702±6.43	84.95%
T2	355.33±0.58	53.00±2.31*	1347±3.06	73.45%*
T3	1371.67±4.30*	55.00±0.00*	1450±2.00	69.90%
T4	475.33±1.10	25.00±1.00*	2000±3.51	78.76%*
T5	357.00±2.40	30.00±1.53*	2799±1.15*	68.14%*
T6	1211.67±1.53*	24.33±0.58*	1497±3.06	64.60%
T7	640.67±1.15*	32.00±1.53*	2295±6.43*	57.50%
T8	1021.00±1.73*	84.50±1.53*	2432±1.25*	63.70%
T9	1118.00±7.21*	25.67±0.58*	3002±5.29	66.37%
T10	1243.33±5.77*	24.00±0.00*	2704±5.29	76.1%*
T11	850.00±2.00*	24.33±0.58*	2302±5.29*	65.40%
T12	822.67±4.62*	33.00±2.65*	2498±3.46*	60.17%
T13	707.33±1.10*	31.33±0.58*	2944±7.57*	73.45%*
T14	874.00±0.01*	48.00±0.00*	1997±3.06	75.22%*
T15	1605.67±4.93*	39.33±1.15*	3372±4.5*	65.48%
T16	1336.00±5.29*	24.67±1.15*	4945±6.43*	70.79%*
T17	1120.67±1.15*	75.00±0.02*	7444±5.03*	71.68%*
T18	1536.67±5.77*	56.00±0.01*	3402±6.43*	50.44%
T19	1000.6±1.158*	39.33±1.15*	2600±1.15*	81.41%*
T20	765.67±4.93*	25.00±1.00*	4199±5.03*	76.99%*
T21	762.00±5.29*	34.67±0.58*	1702±6.43	78.76%*
T22	997.33±4.62*	33.33±1.15*	1709±9.02	84%*
T23	1081.33±1.15*	35.67±0.58*	2308±7.57*	77.8%*
T24	603.33±5.77*	26.6±1.1*	4106±1.1*	75.22%*
T25	1424.00±5.29*	31.20±0.01*	2592±6.43*	69.9%*
T26	982.00±3.46*	51.20±2.00*	3743±8.33*	73.45%*
T27	780.67±1.15*	43.80±0.58*	1439±3.5	37.16%
T28	1617.33±3.00*	48.00±0.00*	1532±3.8	67.25%*
T29	1020.00±1.00*	26.00±2.00*	3597±7.0*	80.53%*
T30	877.33±3.06*	39.00±1.00*	3955±5.0*	73.45%*
T31	664.00±1.40*	61.30±1.00*	3525±2.6*	71.68%*
T32	1022.00±2.00*	26.00±2.00*	1516±6.5	60.00%
T33	602.00±3.46*	24.67±0.58*	1452±5.29	59.00%

T-Control, Dapoli-1 *Significant at the 0.05 level.

a. Dunnett t-tests treat one group as a control and compare all other groups against it.

reported the highest phenolic content (15.1-55.3 µmol of ferulic acid /gm) and antioxidant activities (45% to 82%) among different millet such as finger, proso and foxtail millet.

Variation in the amount of biochemical is influenced by several factors like genotype, various agro-climatic factors. In our survey, we noted that cultivation practices vary from region wise and this might be one the cause for variation in nutritional components and phytochemicals.

CONCLUSION

Results of the present studies focus on nutritional diversity and variation in antioxidant activity existed among the landraces. Work provides nutritious landraces such as T1 contain higher amount of protein, T1, T19 and T29 exhibit high antioxidant activity. These landraces can be serve as a natural source of nutritional compounds. Further, these landraces serve as a good source of anti-oxidants and important phytochemicals. Grains of nutritional landraces or use of value addition technique may help to minimise micronutrient deficiencies specifically in the remote regions. Despite nutritional landraces can be serve as a source of nutritional traits in crop improvement programme.

ACKNOWLEDGEMENT

The authors thanks to Principal, H.P.T. Arts and R.Y.K. Science College, for providing all the required facilities. One of the authors (T.K.) thanks University Grants Commission, New Delhi, India for Financial assistance under Maulana Azad National Fellowship (MANF-2015-2017-MAH-54464).

REFERENCES

Antony, U. and Chandra, T.S. (1999). Enzymatic treatment and use of starters for the nutrient enhancement in fermented flour of red and white varieties of finger millet (*Eleusine coracana*). Journal of Agricultural and Food Chemistry. 47(5): 2016-2019.

Auti, S.G., Kazi, T. and Ahire, D.D. (2017). Morpho-agronomic diversity in [*Eleusine coracana* (L.) Gaertn]. landraces from Maharashtra State (India). Journal of Scientific Agriculture. 1: 54-61.

Barbeau, W.E. and Hilu, K.W. (1993). Protein, calcium, iron and amino acid content of selected wild and domesticated cultivars of finger millet. Plant Foods for Human Nutrition. 43(2): 97-104. doi: 10.1007/bf01087914.

Blois, M.S. (1958). Antioxidant determinations by the use of a stable free radical. Nature. 26: 1199-1200.

Bravo, L. (1998). Polyphenols: Chemistry, dietary sources, metabolism and nutritional significance. Nutrition Reviews. 56(11): 317-333.

Chang, C., Yang, M., Wen, H. and Chern, J. (2002). Estimation of total flavonoids content in *Propilis* by two complementary colorimetric methods. Journal of Food Drug Analysis. 10: 178-182.

Chethan, S. and Malleshi, N. (2007). Finger millet polyphenols: Optimization of extraction and the effect of pH on their stability. Food Chemistry. 105(2): 862-870.

David, A.V., Arulmoli, R. and Parasuraman, S. (2016). Overviews of biological importance of quercetin: A bioactive flavonoid. Pharmacognosy Reviews. 10(20): 84-89.

Dreywood, R. (1946). Industrial Engineering Chemistry, Analytical edition. 18 pp. 499.

Dykes, L. and Rooney, L. (2007). Phenolic compounds in cereal grains and their health benefits. Cereal Foods World. 52: 105-111.

Farkas, G.L., Kiraly, Z. (1962). Role of phenolic compound in the physiology of plant diseases and disease resistance. Phytopathologische Zeitschrift. 44: 105-150.

Geetha, M., Suryanarayanan, H. and Nair, N.B. (1990). On the food and feeding habits of *Puntius* vittatus. Indian National Science Academy. 56: 327-334.

Gopalan, C., Rama Sastri, B.V. and Balasubramanian, S.C. (2009). Nutritive value of Indian foods: National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, pp. 204.

Gosh, H.P, Sarkar, P.K. and Guha, B.C. (1963). Distribution of the bound form of nicotinic acid in natural material. Journal of Nutrition. 79: 451.

Katake, S.B., Kachare, D.P., Naik, R.M. (2016). Evaluation of finger millet genotypes for proximate composition and antinutrients content. International Journal of Science Environment and Technology, 5(5): 3596 -3602..

Kazi, T. and Auti, S.G. (2017). Screening of higher mineral containing finger millet landraces from Maharashtra. International Journal of Food Science and Nutrition. 2(3): 21-25.

Kumar, A., Tomer, V., Kaur, A., Kumar, V. and Gupta, K. (2018). Millets: A solution to agrarian and nutritional challenges. Agriculture and Food Security. 7(1): 1-15.

Kumari, D., Madhujith, T. and Chandrasekara, A. (2017). Comparison of phenolic content and antioxidant activities of millet varieties grown in different locations in Sri Lanka. Food Science and Nutrition. 5(3): 474-485.

Malleshi, N.G. (2003). Decorticated Finger Millet (*Eleusine coracana*). US Patent No. 2003/0185951.

Marathe, C.L. and Bhaskar, V.V. (2011). Germplasm collection of finger millet [*Elucine Coracana* (L.) Gaertn] land races grown by tribals of Thane district Maharashtra. International Journal of Current Research. 3(6): 24-28.

Nelson, N. (1944). Photometric adaptation of the Somogyi method for the determination of blood glucose. Journal of Biological Chemistry. 153: 375-380.

Pearson, D. (1976). The Chemical Analysis of Foods, 7th Ed. Churchill Livingstone. Edinburgh. 9-13.

Rao Subba, M.V.S.S.T. and Muralikrishna, G. (2002). Evaluation of the antioxidant properties of free and bound phenolic acids from native and malted finger millet (Ragi, *Eleusine coracana* Indaf - 15). Journal of Agriculture and Food Chemistry. 50(4): 889-892.

Rao, B.S.N. and Prabhavathi, T. (1982). Tannin content of foods commonly consumed in India and its influence on ionisable iron. Journal of the Science of Food and Agriculture. 33(1): 89-96.10.1002/jsfa.2740330116.

Sahrawat, K.L., Ravi Kumar, G. and Murthy, K.V.S. (2002). Sulphuric acid Selenium digestion for multi element analysis in a single plant digests. Communications in Soil Science and Plant Analysis. 33: 3757-3765.

Shimelis, A., Mulugela, T. and Dawit, A. (2009). Chemical composition of local and improved finger millet [*Eleusine coracana* (L.) Gaertn] varieties grown in Ethiopia. Ethiopian Journal of Health Sciences. 19(1): 1-18. https://www.ajol.info/index.php/ejhs/ issue/view/14822

Shobana, S., Harsha, M.R., Platel, K., Srinivasan, K. and Malleshi, N.G. (2010). Amelioration of hyperglycaemia and its associated complications by finger millet (*Eleusine coracana* L.) seed coat matter in streptozotocin-induced diabetic rats. British Journal of Nutrition. 104(12): 1787-1795.

Singh, P. and Raghuvanshi, R.S. (2012). Finger millet for food and nutritional security. African Journal of Food Science. 6(4): 77-84.

Siwela, M., Taylor, J.R.N., de Milliano, W.A.J. and Duodu, K.G. (2007). Occurrence and location of tannins in finger millet grain and antioxidant activity of different grain types. Cereal Chemistry. 84: 169-174.

Sripriya, G., Antony, U., Chandra, T.S. (1997). Changes in carbohydrate, free amino acids, organic acids, phytate and HCl extractability of minerals during germination and fermentation of finger millet (*Eleusine coracana*). Food Chemistry. 58: 345-350.

Udeh, H.O., Duodu, K.G. and Jideani, A. (2018). Malting period effect on the phenolic composition and antioxidant activity of finger millet [*Eleusine coracana* (Gaertn.)] flour. Molecules (Basel, Switzerland). 23(9):1-12. doi: 10.3390/23092091.

Viswanath, V., Urooj, A. and Malleshi, N. (2009). Evaluation of antioxidant and antimicrobial properties of finger millet polyphenols (*Eleusine coracana*). Food Chemistry. 114(1): 340-346.

Wadikar, D.D., Premvalli, R.S., Satyanarayanswamy, Y.S. and Bawa, A.S. (2007). Lipid profile in finger millet. Journal of Food Science and Technology. 44(1): 79-81.