ISSN: 2347-467X, Vol. 09, No. (3) 2021, Pg. 1067-1073

Current Research in Nutrition and Food Science

www.foodandnutritionjournal.org

Evaluation of Nutritional and Nutraceutical Content of Polished and Unpolished Barnyard Millet – An Analytical Study

N. RAJESWARI* and V. PREMALA PRIYADHARSHINI

Department of Food Service Management and Dietetics ,Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamilnadu, India.

Abstract

Barnyard millet (*Echinochloa frumentacaea*) is an indigenous under utilized millet variety of south India with bounty of health benefits due to the abundance of dietary fiber antioxidant and minerals like iron. This gluten free wonder millet can be a healthy alternate dietary source for diabetic, obesity and CVD patients. Scientific evidence based studies on nutritional quality of this millet both in polished and unpolished form is less. The current study aims at "Evaluation of nutritional and nutraceutical content of polished and unpolished barnyard millet". Both polished and unpolished barnyard millets were procured from local market, cleaned to remove dirt, dust and stone. The cleaned millets were dried powdered and sieved using 60 mesh sieves (250 Micron). The powdered millet flour was stored in airtight container. Nutritional content of Barnyard millet was analysed for macro, micro nutrients and nutraceutical properties of both polished and unpolished form using standard AOAC method - 20th edition (2016). The analysed nutrient content were compared statistically at 99% and 95 % confidence interval (t-test). The result shows that, the quantum of carbohydrate present in polished barnyard millet was 11.37 % lesser than the milled parboiled rice and 9 % lesser than the brown rice and 12.45 % lesser than the raw milled rice. The total dietary fibre content of unpolished barnyard millet was 14.2 gm and polished barnyard millet was 8.5 gm. Crude fibre content of unpolished barnyard millet was noted as 11.2 gm and the same in polished barnyard millet was 4.5gm. The protein content of unpolished barnyard millet (10.4gm) was found to be superior to polished barnyard millet (6.8gm).The presence of nutraceutical components were more nutritionally superior in unpolished barnyard millet compared to polished one.

Article History
Received: 25 January 2021
Accepted: 05 July 2021

Keywords
Barnyard millet;
Nutraceutical;
Nutritional;
Phytochemicals;
Polished;
unpolished Barnyard Millet.

CONTACT N. Rajeswari rajeswari151979@gmail.com Department of Food Service Management and Dietetics ,Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamilnadu, India.

Doi: http://dx.doi.org/10.12944/CRNFSJ.9.3.31

Introduction

Millets, deliberated as main food staples in human history, have a substantial economic impact on developing countries because of its importance as a crop at a global level.[1,2] India is the world's prominent manufacturer of millet.[3] For boosting millet production as well, India celebrated National Year of Millets as 2018.[4] In India barnyard millet is usually cultivated under rain fed conditions.5In which, barnyard millet agronomy is limited to hilly and semi-arid areas of Southern headland of Tamil Nadu, Andra Pradesh, Karnataka and Northern states of Jharkhand and Uttar Pradesh.6Banyard millet comparable to any other millet is nutritionally superb to cereals, so far its consumption is narrowed.[3]

Comparable to other cereals, millets are tremendous source of energy, carbohydrate, and protein. They remain also rich in phytochemicals and micronutrients. Phytochemicals are the naturally active organic substance of plant basis which are involved in stopping disease and upholding health. The rerun of these phytochemicals can support in recognizing the lively compounds responsible for disease avoidance due to their antioxidant and antimicrobial properties.[3,7,8] Millets are recognized as nutraceuticals because of their dietary fibres, proteins, energy, minerals, vitamins and antioxidants quality that they offer for human health.[9] Ingeneral millets protect health with its nutritional and nutraceutical content for a healthy living.[10,7]

Phytochemicals and phenolic compounds in minor millets enriches its antioxidants activity and makes it nutritionally superior to other cereals.[3] Barnyard millets also known as minor millets, Japanese barnyard millet, Ooda, Oadalu,Sawan,Sanwa,and Sanwank, is a fastest multipurpose crop, which yields food and feeds in a short duration. Barnyard millet is a wonderful cereal. While equate to rice and wheat, moreover having mineral and vitamins, it is an amusing source of treasured nutrients like carbohydrates, fat, proteins, and crude fiber. In fact with delayed digestibility rate, barnyard millets have a fair source of protein with low carbohydrate content which makes it as a natural nutraceuticals food, especially for individual with high risk for non-infectious diseases such as diabetes, heart diseases, obesity, and cancer.[6,11] The presence of phytochemicals, by means of phenolic acids, catechins, phytic acid, flavonoids and tannins in the barnyard millet work as noble source of natural antioxidant.[12] The existence of high of amount bioactive constituents in barnyard millet thereby, recommending it as a possible healthy alternate for rice and wheat particularly for the patients with cardiac disease and diabetes.[13] De-hulled varieties of barnyard millet are beneficial for Type II diabetics, due to their delayed glycaemic response.[14]

Even though the whole grains / unpolished of barnyard millet (without removal of bran) offer a wide range of nutrients and phytochemicals that enhance health, direct consumption of them by humans is less explored, citing the reason of delayed digestibility and acceptability, thus the present study aims at examining nutritional and nutraceutical quality of both polished and unpolished barnyard millet quantitatively.

Materials and Methods

Procurement and and Processing of Barnyard Millet Sample

Unpolished barnyard millet was procured from the local farmers and polished barnyard millet from a local shop from the city of Coimbatore, Tamil nadu, India. Barnyard millet both polished and unpolished were cleaned to remove dirt, dust, and stone. The cleaned millets (sample) were powdered and sieved using 60 mesh sieves (250 Micron). The powdered flour was stored in an airtight container at room temperature for analysis. All samples were analyzed in triplicate for quantitative analysis.

Analysis of Macronutrients Present In both Polished and Unpolished Barnyard Millet

Quantitative analysis of both polished and unpolished barnyard millet, for their moisture (AOAC 934.01) and ash (AOAC 942.05) using gravimetric method (AOAC 942.05). Calculation of energy by proximate principle and analysis of other nutrients such as carbohydrate (uv- visible spectrophotometer, 630nm), protein (kjeldahl method - AOAC 2011.11), fat (gravimetric method - AOAC 963.15), crude fibre (gravimetric method- AOAC 962.09) and fibre including soluble, insoluble and total dietary fibre (enzymatic- gravimetric method - AOAC 991.43) was carried out using standard analytical methods - AOAC, 2016.[15]

Analysis of Micronutrients Present in both Polished and Unpolished Barnyard Millet

Quantitative analysis of both polished and unpolished barnyard millet, for their micronutrients namely calcium and iron (ICP-OES method-AOAC 2011.14), vitaminC (HPLC- AOAC 2012.21) and B- complex vitamins(uv- visible spectrophotometer-AOAC 2012.10) such as thiamine (420nm), riboflavin(330nm), niacin (262nm), pantothenic acid (220nm), total B6 (716nm), biotin (348nm), total folate (540nm) was carried out using standard analytical methods -AOAC, 2016.[15]

Analysis of Nutraceutical Content Present in both Polished and Unpolished Barnyard Millet

Nutraceutical content of both polished and unpolished barnyard millet was determined using standard AOAC methods 201615 for phenolic acid(550nm), phytic acid (519nm), tannin (725nm), flavonoids (510nm), saponins(435nm), alkaloids (470nm), catechins(760nm), phytosterols(625nm) by uv-visible spectrophotometer at respective wavelength. Similarly Carotenoids (450nm) and tocopherols (520nm) by colorimetric method. Also lignin(chemical oxidation and extraction method,205nm) and arabinoxylans (acid hydrolysis method,620nm). Analysis of starch and individual sugars present in both polished and unpolished barnyard millet.

The total starch (510nm) and the reading for sugars such as fructose, glucose, sucrose and maltose was noted at a wavelength of 500 nm, 540nm, 340nm and 334nm respectively (AOAC 2018.01) were analysed using standard analytical methods -AOAC, 2016.[15] The available carbohydrate was calculated by substracting total dietary fibre from the total carbohydrate present in barnyard millet.[16]

The Ethical Clearance for the study was obtained from Institutional Human Ethics Committee-Avinashilingam Institute for Home Science and Higher Education for Women. (Approval No-AUW/IHEC-17-18/FSMD/FHP-02).

Data were analyzed using SPSS version 21.0. Mean, the standard deviation of all the values was calculated. The observed results were compared using Paired t-test at 99% or 95% confidence interval to indicate significance level.

Table 1: Quantitative analysis of macro nutrients present in barnyard millet (100g)

Serial NO	Macro nutrients	Mean of macro nutrients		p-value
		Polished	Unpolished	
1	Carbohydrate (gm)	65.79 ± 0.02	68.8 ± 0.11	<0.01a
2	Energy (Kcal)	327.3 ± 0.08	351 ± 0.2	<0.01a
3	Protein (gm)	6.8 ± 0.08	10.4± 0.02	<0.01a
4	Total Fat (gm)	4.1 ± 0.16	3.8 ± 0.02	>0.05c
5	Moisture (gm)	9.3 ± 0.03	9.8 ± 0.05	<0.01a
6	Ash (gm)	0.09 ± 0.08	0.45 ± 0.01	<0.05b
7	Soluble Fibre (gm)	2.3 ± 0.1	4.4 ± 0.1	<0.01a
8	Insoluble Fibre (gm)	6.2 ± 0.11	9.8 ± 0.1	<0.01a
9	Total Dietary Fibre (gm)	8.5 ± 1.3	14.2 ± 0.28	<0.05b
10	Crude Fibre (gm)	4.5 ± 0.35	11.2 ± 0.08	<0.01a

[a]1percent level of significance ; [b]5 percent level significance ; [c]not significant.

Result and Discussion

The amount of carbohydrate present in 100gm of polished and unpolished barnyard millet was found to be 65.79 ± 0.02 gm and 68.8 ± 0.11 gm respectively (Table 1). On a comparative note, the quantum of carbohydrate present in polished barnyard millet was 12.1% lesser than the milled parboiled rice and 12.45% lesser than milled raw rice.[17] Similarly, the amount of carbohydrate present in unpolished barnyard millet was 6%lesser than that of brown rice. However the carbohydrate present in barnyard millet (polished and unpolished) closely concurence with

that of other millets namely jowar (67.68 gm),ragi (66.82gm), samai (65.55gm), varagu (66.19gm) and whole wheat flour(64.19 gm) thus making it a perfect a healthy choice for therapeutic use.

The protein content of unpolished barnyard millet (10.4± 0.02gm) was found to be significantly superior to polished barnyard millet (6.8 ± 0.08gm) at 1% level of significance which can be recognized to the heavy loss of protein existing in the peripheral layers of barnyard millet during the milling process. However no significant difference in the total fat content between the polished and unpolished barnyard millets were observed.

Table 2: Quantitative analysis of micro nutrients present in barnyard millet (100g)

Serial NO	Macro nutrients	Mean of micro nutrients		p-value
		Polished	Unpolished	
1	Calcium (mg)	24.8 ± 0.38	35 ± 0.10	<0.01[a]
2	Iron (mg)	6.2 ±0.02	7.1 ±0.11	<0.01[a]
3	Thiamine (B1)- mg	0.37 ±0.01	0.45 ±0.04	<0.05[b]
4	Riboflavin (B2)- mg	0.13 ± 0.02	0.14 ± 0.02	>0.05[c]
5	Niacin (B3)- mg	4.05 ± 0.02	4.08 ± 0.01	<0.05[b]
6	Pantothenic Acid (B5)- mg	0.22 ± 0.08	0.25 ±0.03	>0.05[c]
7	Total B6 (mg)	0.08 ± 0.01	0.13 ± 0.07	>0.05[c]
8	Biotin (B7)µg	20 ± 0.20	22 ± 0.16	<0.01[a]
9	Total Folate, B9 - µg	69 ± 0.30	78 ± 0.01	<0.01[a]
10	Total Ascorbic Acid (Vitamin C) - mg	0.11 ±0.01	0.06 ±0.01	<0.01[a]

[a]1percent level of significance ; [b]5 percent level significance ; [c]not significant.

Table 3: Quantitative analysis of micro nutrients present in barnyard millet (100g)

Serial NO	Macro nutrients	Mean of nutraceuticals nutrients		p-value
		Polished	Unpolished	
1	Phenolic Acids (mg/g)	10.30 ± 0.03	11.28 ± 0.03	<0.01[a]
2	Tannins (mg/g)	12.00 ± 0.02	9.78 ± 0.02	<0.01[a]
3	Flavonoids (mg/g)	46.20 ± 0.01	54.00 ±1.00	<0.01[a]
4	Lignin (mg/g)	7.20 ±0.02	6.60 ± 0.11	<0.0[a]
5	Catechins (µg/g)	9.20 ± 0.01	11.00 ± 0.05	<0.01[a]
6	Phytic Acid (mg/g)	0.61 ± 0.01	0.52 ± 0.02	<0.05[b]
7	Phytosterols (mg/g)	0.06 ± 0.02	0.05 ± 0.01	>0.05[c]
8	Arabinoxylans (µg/g)	4.50 ± 0.25	4.20 ± 0.02	>0.05[c]
9	Carotenoids (mg/g)	2.56 ± 0.19	2.85 ± 0.02	> 0.05[c]
10	Alkaloids (mg/g)	5.11 ± 0.04	3.80 ± 0.01	<0.01[a]
11	Saponins (mg/g)	1.80 ± 0.10	2.20 ± 0.40	> 0.05[c]
12	Tocopherols (mg/g)	0.08 ± 0.02	0.04 ± 0.03	< 0.05[b]

[a]1percent level of significance ; [b]5 percent level significance ; [c]not significant.

The analysed micro nutrients content of barnyard millet significantly varied between the polished and unpolished samples at 1% level of significance for nutrients namely calcium, iron, Biotin, total folate and total ascorbic acids. However no significant difference between the polished and unpolished

barnyard millets for Riboflavin (B2), Pantothenic Acid (B5) and Total B6 was observed in the present study.

A significant loss ($p \leq 0.05$) of nutraceutical components or secondary metabolites namely phenolic acids, flavonoids and catechins between polished and unpolished barnyard millet was observed. Polishing of barnyard millet results in loss of phytochemicals and antioxidant content present in brans.[18]

Table 4: Quantitative analysis of starch and individual sugars present in barnyard Millet (100g)

Serial NO	Macro nutrients	Mean of starch and individual sugars		p-value
		Polished	Unpolished	
1	Total Available Carbohydrate(gm)	61.30 ± 0.04	57.60 ± 0.21	<0.01a
2	Total Starch(gm)	59.96 ± 0.35	56.80 ± 0.21	<0.05b
3	Fructose (gm)	0.25 ± 0.01	0.18 ± 0.01	<0.05b
4	Glucose (gm)	0.75 ± 0.01	0.52 ± 0.03	<0.01a
5	Sucrose (gm)	0.39 ± 0.01	0.10 ± 0.01	<0.01a
6	Maltose (gm)	0.01 ± 0.01	0.00 ± 0.00	>0.05c

[a]1percent level of significance ; [b]5 percent level significance ; [c]not significant.

We observed a significant (p<0.01**) difference in the total available carbohydrate between polished and unpolished barnyard millets at 1 % level of the significance which can be attributed to the higher level of total dietary fiber content (14.2 ± 0.28gm) of unpolished barnyard millets. Also since the quantum of the available amount of carbohydrate is directly proportional to the glycemic response, unpolished barnyard millets can be considered for incorporated in other cereals or as a healthy replacement for other cereals for the better dietary management of diabetes, obesity and cardiovascular diseases. Also except for maltose a significant difference in sucrose, glucose and fructose levels between polished and unpolished barnyard millets was observed at 99% or 95% confidence interval to indicate significance level.

Discussion

A significant difference in Crude fiber (p value <0.01**), Insoluble(p value<0.01**) ,soluble fiber (p value <0.01**) and total dietary fiber(p-value <0.05*) was witnessed between polished and unpolished barnyard millets at 1 and 5% level of significance. Also, it was observed that the total fiber, the insoluble and soluble fiber content of unpolished barnyard millets were more or less similar to the total fiber, insoluble and soluble content of jowar (total fiber 10.22gm, insoluble,8.4gm and soluble 1.73gm) and wheat whole flour (total fiber 11.36gm, insoluble,9.7gm and soluble1.63 gm) as reported in nutritive value of Indian foods (IFCT-2017).[17]

The nutritious quality of milled barnyard millets at different moisture levels which showed a undesirably and linearly associated relationship with the grade of polishing,[19] is concurrence with the difference in nutrient content observed between polished and unpolished barnyard millets in the present study. Thus the unpolished or whole barnyard millets can be a healthy replacement of carbohydrate and dietary fiber for patients with insulin insensitivity.

We found that the analyzed thiamine value of unpolished barnyard millet (0.45 ±0.04 mg) was greater than that of whole grains of jowar (0.35±0.04mg), ragi (0.37±0.04mg) and maize (0.33±0.03mg) and more or less same as that of wheat flour (0.42 ±0.04mg) and whole wheat (0.46 ±0.07mg) as stated in the nutritive value of Indian foods (IFCT-2017).[17] We also observed a higher amount of total folate in polished barnyard millet (69 ± 0.3 µg) and unpolished barnyard millet (78 ± 0.01 µg). The iron content of barnyard millet both polished (6.2 ±0.02mg) and unpolished (7.1 ±0.11mg) was found to be higher compared to other millets except amaranth seed (8.02 ± 0.93 mg)and quinoa (7.5 mg). The analyzed value of iron content

in barnyard millet reported in our study is similar to one estimated (6.91 mg/100 g) in another study in which nutritional and sensual feature of foxtail and barnyard millet foodstuffs with traditional rice products were compared. However in the present study we have also analyzed the iron content of unpolished barnyard millet which can serve as a nutrient source for future reference.

A significant upward trend ($p \leq 0.05$) in the levels of tannins, lignins, phytic acid, alkaloids, and tocopherols were observed in polished barnyard millet in comparison to unpolished/whole millet. Also the quantum of tocopherols, alkaloids, and saponins present in both polished and unpolished barnyard millets was found to be inferior to the commonly consumed millets such as ragi (0.16 ±0.01mg), jowar 0.36 ±0.3mg and cereals such as brown rice (0.69±0.12mg) and whole wheat flour (0.26 ±0.09mg). Furthermore no significant difference in Phytosterols, carotenoids, and saponins levels were observed between polished and unpolished barnyard millet. Henceforth, these variations in nutraceutical components call for future research on the extent of polishing barnyard millets to make it as a healthy nutritious choice for human consumption, especially for the diabetic population without compromising the nutraceutical potentials.

Conclusion

Both polished and unpolished barnyard millet was tested quantitatively for its nutritional and nutraceutical benefits, the results show that majority of the macro, micro, and nutraceutical components were more nutritionally superior in unpolished barnyard millet than polished one. Consumption of barnyard millets loaded with biologically active phytochemicals and nutraceutical compounds such as flavonoids, tannins, lignin, phenolic compounds, and other antioxidants can be encouraged to prevent and protect us from non-communicable lifestyle disorders and to nurture health society. Development of nutritious healthy millet replaced snacks, main dishes and accompaniment can not only add variety to the diet but can also serve as a healthy alternate for other staple cereals, particularly the rice. Thus as salient outcome , the present study on the nutritional quality of both polished and unpolished barnyard millet serve as an knowledge source of nutrient content for future scientific study.

Acknowledgement

The authors acknowledge Avinashilingam Institute for Home Science and Higher Education for Women for providing us the platform to conduct the research work.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of interest

The author(s) declares no conflict of interest. The Ethical clearance (Approval No-AUW/IHEC-17-18/FSMD/FHP-02) for the research work from Institutional Human Ethics Committee-Avinashilingam Institute for Home Science and Higher Education for Women was obtained.

Reference

1. Lu H., Zhang J., Liu K.B., Wu N., Li Y., Zhou K., Ye M., Zhang T., Zhang H., Yang X., Shen L. Earliest domestication of common millet (Panicum miliaceum) in East Asia extended to 10,000 years ago. *Proceedings of the National Academy of Sciences*. 2009 ;106(18):7367-72.
2. Nithiyanantham S., Kalaiselvi P., Mahomoodally M. F., Zengin G., Abirami A., Srinivasan G. Nutritional and functional roles of millets—A review. *Journal of food biochemistry.* 2019 ;43(7):01-10.
3. Prabha K. C., Selvi S. Nutrient and Antioxidant Evaluation of Four Underutilized Minor Millets. *Int J Curr Microbiol Appl Sci.* 2016;5(7):224-233.
4. FAO. The hundred and sixtieth session council. Proposal for an International Year of Millets. Rome, 2018; 01-09.
5. Kandlakunta B., Golla S.D. Nutritional and Health Benefits of Millets. ICAR- Indian Institute of Millets Research, Hyderabad ; 2017.
6. Veena S., Chimmad B. V., Naik R. K.,

Shanthakumar G. Physico-Chemical and Nutritional Studies In Barnyard Millet. *Karnataka J Agric Sci.* 2005;18(1):101-105.

7. Chauhan M, Sonawane S. K., Arya S. S. Nutritional and Nutraceutical Properties of Millets - A review. *Clinical Journal of Nutrition and Dietetics.* 2018;1(1):1-10.
8. Rao B. N. Bioactive phytochemicals in Indian foods and their potential in health promotion and disease prevention. *Asia Pac J Clin Nutr.* 2003;12(1):9-22.
9. Gupta N, Srivastava A. K., Pandey V.N. Biodiversity and nutraceutical quality of some Indian millets. *Proc Nati Acad Sci India Sect B - Biol Sci*. 2012;82(2):265-273.
10. Singh, Sarita. Nutraceutical and food processing properties of millets: a review. *J Nutr Food Sci.* 2016;4(1):1077.
11. Devi P. B., Vijayabharathi R., Sathyabama S., Malleshi N.G., Priyadarisini V.B. Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: A review. J Food Sci Technol. 2014;51(6):1021-1040.
12. Kulkarni L. R., Naik R.K., Katarki P.A. Chemical composition of minor millets. *Karnataka J Agric Sci.* 1992; 5(3):255-8.
13. Panwar P., Dubey A., Verma A. K. Evaluation of nutraceutical and antinutritional properties in barnyard and finger millet varieties grown in Himalayan region. *J Food Sci Technol.* 2016;53(6):2779-2787.
14. Ugare R., Chimmad B., Naik R., Bharati P., Itagi S. Glycemic index and significance of barnyard millet (Echinochloa frumentacae) in type II diabetics. *J Food Sci Technol.* 2014;51(2):392-395.
15. Latimer G.W.Official Methods of Analysis of Aoac International.20thedn,Rockville,Maryland,USA;2016.
16. Narayanan J., Sanjeevi V., Rohini U., Trueman P., Viswanathan V. Postprandial glycaemic response of foxtail millet dosa in comparison to a rice dosa in patients with type 2 diabetes. *The Indian journal of medical research.* 2016;144(5):712.
17. Longvah T., Ananthan R., Bhaskarachary K., Venkaiah K. Indian Food Compostion Tables. National Institute of Nutrition, Hyderabad; 2017.
18. Nirmala B.Y., Hanchinal R.R., Basarkar P. W. Antioxidant contents of whole grain cereals, millets and their milled fractions. *Journal of Dairying Foods & Home Sciences* 2011; 30(3):191-6.
19. Lohani U. C., Pandey J. P., Shahi N. C. Effect of Degree of Polishing on Milling Characteristics and Proximate Compositions of Barnyard Millet (Echinochloa frumentacea). *Food Bioprocess Technol.* 2012; 5(3):1113-1119.
20. Verma S., Srivastava S., Tiwari N. Comparative study on nutritional and sensory quality of barnyard and foxtail millet food products with traditional rice products. *J Food Sci Technol.* 2015;52(8):5147-51.