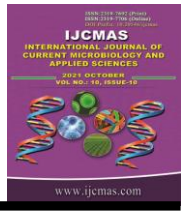
Int.J.Curr.Microbiol.App.Sci (2021) *10*(10): 163-175

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 10 (2021)**
Journal homepage: http://www.ijcmas.com



Review Article https://doi.org/10.20546/ijcmas.2021.1010.019

Nutritional Quality of Millets and their Value Added Products with the Potential Health Benefits: A Review

Pragya Mishra*, H. G. Prakash, Suman Devi, SeemaSonkar, Shweta Yadav, H. C. Singh and D. R. Singh

Centre for Advanced Agricultural Science and Technology on Nutritional Crops, Chandra Shekar Azad University of Agriculture and Technology, Kanpur, India

**Corresponding author*

Keywords

Millet, Processing, Nutritive value, Value added products, Health benefits

Article Info

Accepted:
10 September 2021
Available Online:
10 October 2021

A B S T R A C T

Raising population at global level needs solving the problems related to food and health due imbalance use of fast foods of high calories. The problems of obesity, diabetes, cardiac arrests, porous bones, depressions etc. are so called general diseases of modern era. So many cereals are available which economically feasible and tasty but not healthy. At present people are very conscious with health. Millets are one of the best solution to found highly nutritious and health benefits in pandemic era. Researchers are proving that millet has a better option to other cereals. It contains energy, protein, vitamins, minerals and phytochemicals. Value added products of millets are possible to solve negative effect of agriculture and food security. So the review focused on millet nutritive value, health benefits, processing techniques with their value added products to enhance consumption of health.

Introduction

Millets are traditional 6th crop and cultivated in past 50 years ago use as fodder and human meal. It is also called a poor man food. This crop is cultivated in China, Greece, Egypt, Africa and India. In India millets are produced in about 21 states, Karnataka, Tamil Nadu, Andhra Pradesh, Kerla, Hyderabad, Telangana, Uttarakhand, Jharkhand, and Madhya Pradesh, Karnataka state is a major producer of millets and 58 percent the global production of millets Upadhayaya *et al.*, (2007). Millets are semi arid, short growing, under dry and high temperature season crop. Millets are classified into major and minor groups, sorghum (jower), pearl millet (bajara), finger millet (ragi) major millets and porso millet (chenna), foxtail millet(kakun), kodo millet(kodon), baryard millet (sanwa), little

millet (shavan) minor millets. Millets are high nutritive value, gluten free, acid free forming food which also contains nutraceutical properties. Millets have a good source of protein(essential amino acid), micronutrient and phyto chemicals. It plays significant role as health promoter and also help in preventing diabetes, hiperlipidemia, etc Veena (2003). Wheat and rice are major crop and msideline of millets in Indian basket due to its taste and lack of awareness of about their health benefits Vilas. A. Tonpai, IIMR, (1970). Millets have more than 3 to 5 percent nutritional content in comparison to rice and wheat. Wheat and rice crop gives the food securities but millet provides many securities like nutrition, food, health, livelihood and animal food. Millets consumed by more than one third population of the world. Traditional consumers are used millets as a food in limited area in limited area where the cultivation and under utilized. The processing have a method for the formulation of fortified and value added products. Different types of products are prepared viz ready to use, ready to cook, and ready to eat, these would help to increasing the consumption of millets for the non-millet consumers. The review paper focused on the brief information of millet, processing, value added products and their health benefits.

Production and consumption

Table 1 and 2 showed that millets are coarse crop growing where the most of grain would fail. Millets yield decrease from 68.4 million hectares in 1974, 43.4 million hectares in 1980 and 37.6 million in 1997 to 98. The average of millets in India is about 7.9 quintal per hectare. The enhanced yield of millets was around 82% in finger millet, 95% in little millet, 83% in kodo millet, 43% in foxtail millet, 76% in porso millet and 82% in barnyard millet due to use of new recommended technology (Michaelraj *et al.*, 2013). In India millets are produced in about 21 states, Karnataka, Tamil Nadu, Andhra Pradesh, Kerala, Hyderabad, Telangana, Uttarakhand, Jharkhand, and Madhya Pradesh, Karnataka state is a major producer of millets and 58 percent the global production of millets (Upadhayaya *et al.*, 2007).

Millets have very important role in Indian foods. According to NSSO Unit the consumption pattern of small millets and finer millets was examined. The small millets consumption pattern was highest in Assam 18.82 Kg/ha/M and 18.6 Kg/ha/M states. Madhya Pradesh has highest area of small millets 32.4% after that 19.5%, Uttrakhand 8%, Maharastra 7.8%, Gujrat 5.3% and 3.9% Tamil Nadu. The productivity has highest as 1174Kg/ha in Uttarakhand followed by 1067/Kg/ha Tamil Nadu and 1056 kg/ha in Gujrat (Anbukkani Pernumal, 2018). Among millets, bajra is the predominant crop in India occupying during 1997-1998 an area of 10.0 million hectares with a production of 7.91 million tones and yield of 7.9 quintals per hectare. The coarse grain contains 8-10% husk. About 85 % of bajra produced in the country is used as food. It constitutes the staple diet of nearly 10 percent of the Indian population. It is consumed after dehusking and cooked as rice. It is more commonly grind into flour and made into chapattis. It is also made thin porridge.

The grain is sometimes eaten after it is parched; the product being similar to popcorn the grain is suitable for preparation of malt. An intoxicating drink is obtained grow its malted grain. They are mostly grown in areas with low rainfall, poor irrigation facilities and low fertility. These are well suited for dry farming. In developing countries with current rate of increase in population and with less than adequate irrigational facilities millet, can equality meet the demand for additional food supply (Manay, 2001).

Aspects of millets with rice and wheat

Table.4 showed that the nutritive value of different types of millets in comparison to other cereals.

Sorghum or Jowar

Sorghum is a staple ancient cereal grain in India and Africa. It is as a safe food grain as a best alternative for celiac disease. In India, the sorghum area was more than 16 million ha in 1981, but gradually decrease to 7.8 million ha in 2007-2008 and still 20 percent of the world in recent years.

Sorghum is best used for the replacement of wheat for making of bread, pasta, cookies, etc. East African people has used brew a drink from sorghum millets known as a ajono. Sorghum contains iron, calcium fiber, protein and wax policosanols which help to reducing cholesterol level and other health benefits. Sorghum has gluten free grain to prefer for celiac person or who cannot tolerate wheat based products O.S.K. Reddy, (2017).

Finger Millet

Finger millet is one of the most valuable nutritious cereals and contains iron, calcium fiber, protein, amino acid (methionoine), which is lacking in the diet for hundred years for poor people who live in starchy staples.

It helps to prevent constipation, anaemia, blood pressure, asthma and heart problems. Finger millets are used to make valuable and nutritious products such as cakes, pudding and porridge.

In Nepal it is used for making fermented drink called bear. It is packed with nutrition which helps to increase haemoglobulin level, degenerative disease and fight against mal nutrition.

Pearl millet

In India, pearl millet is a largest producer in Asia and 8.3 million tons production with an average productivity of 930 kg/ha during the last three years.

It is a good source of fat, magnesium and insoluble fiber. Its flour have poor keeping quality, off flavour and nutty taste due to lipase enzyme but it helps in reducing respiratory disease, migraine and gall stones. Pearl millet contains insoluble fiber which helps in reduction of excessive bile system who leads gallstones Shweta, (2015).

Porso millet

Porso millet has high content of niacin (Vitamin B3) which helps in preventing pellegra. Pellagra is skin disease. It also contains protein, calcium to strengthen the bones and dental health.

Kodo millet

Kodo millet was domesticated in India almost three thousand years ago. It is found in humid, habitats of tropics and sub tropics across the world. It is a minor grain crop and contains antioxidant, phytochemicals and fiber in very high amount. It is a traditional food look like rice to easily digestible and helps in preventing joint, knee pain and women menstruation.

Foxtail millet

It is also called Italian millet and German millet. It is growing both tropics and temperate region under low rainfall. Foxtail millet helps in preventing diabetes to reducing glucose level in blood and maintains the heart due to magnesium content O.S.K Reddy (2017).

Little millet

It is called a little but not less than its nutritional value and it contains vitamin, minerals and essential fatty acid to the body. Little millet is ideal use of pongal or kheer instead of rice and helps in preventing obesity due to its high fiber content O.S.K Reddy, (2017).

Millets are good source of energy and provides protein, fiber, fat, minerals, polyphenols and vitamin. Millet contains high quality and quantity of protein with essential amino acid (methionine and cystein). The millet part germ and bran layer contains fiber and phytochemicals but remove after processing. Millets are good source of antioxidant and probiotic that enhance the functionality and viability. Wheat and rice is major crop and msideline of millets in Indian basket due to its taste and lack of awareness of about their health benefits (Tonpai, IIMR, 1970).

The demand of millet is positively high in the market to examine the nutritional and functional properties (Issoufou amadou *et al.,* 2013). Millets have high nutritional value in comparison to wheat and rice to their cultivating advantage (Parameswaran and Sadasivam 1994). Millets are good source of protein with essential amino acid except lysine and threonine, micronutrients and phytochemicals (Mal *et al.,* 2010 and Singh *et al.,* 2012). Millets contained 81.5 percent carbohyderate, 9.8 percent protein, 4.3 percent crude fiber and 2.7 percent minerals. Millet has a higher amount of crude fiber and minerals in comparison to wheat and rice (Ravindran 1991, Sripriya *et al.,* 1997 The millet flour contained 10.0 percent moisture, 12.7 percent protein, 1.23-4.47 percent crude fat, 2.71-7.02percent total ash and 70.13-75.07gm carbohydrate. The millet foul in blends has increased the nutrient content significantly (Singh *et al.,* 2005). The pearl millet was found higher amount in soluble and insoluble dietary fiber, resistant starch antioxidant and mineral (Ragaee *et al.,* 2006)

The porso millet was found 11.6 percent protein higher than wheat and its grain was significantly rich in essential amino acid (Kalinova and Moudry).Finger millet was found found rich in poly phenols that have a potential health benefits (Chetham and Malleshi, 2007). Black finger millet contained 8.71 mg/gm fatty acid and 8.47 gm/gm protein of dry weight (Glew *et al.,* 2008).

The characteristic of foxtail millet protein is a potential ingredient of functional food and use as a supplementary source of protein to most cereals due to its rich in essential amino acid (lysine) (Mohamad *et al.,* 2009). The bran fraction of pearl millet was 92.5 percent dry matter, 2.1 percent ash, 2.8 percent crude fiber, 13.6 percent crude protein, 7.8 percent crude fat and 63.2 percent starch (Ali *et al.,* 2003).

Processing of Millets & Value added Products

Millets are traditional food for poor farmers in various region of our country. Millets are also called nutri- cereals. Now a day, the demand of millets and their products are increase due to processing technologies to make value added products. Value added products of millets have found easily available, reasonable price and convenient to make in urban area where the people are conscious to take nutritious food. In rural areas, utilization of millet daily intake is found very limited. Processing is the technique for the development of value added products and convenient food products would be solution of promotion and enhancement of consumption of millet (Anjali *et al.,* 2018). Shrama and Kapoor (1991) reported that debarring and

soaking of millets reduced the crude protein, true protein and non-protein nitrogen while autoclaving increased the non-protein count thus reducing the true protein fat content was reduced on debranning and starch was reduced on giving various treatments. Total soluble sugars and reducing sugar increased on germination and autoclaving, whereas non-reducing sugars and reducing sugar decreased after processing. In-vitro digestibility increased after processing treatment of which germination process is to be best. Milling and heat treatment during chapati (an unleavened bread) making decrease the polyphenols and phytic acid and improved the protein digestibility and starch digestibility (Chowdhury and Punia, 1997).

Table.1 Area, production and yield of small millets and finger millet from 1950-2014.

Particulars	1965-66	1975-76	1985-86	1995-96	2005-06	2013-14
Area (Lakh ha) 53.35	45.64	46.72	31.55	16.62	10.64	6.82
Production (Lakh tones) 20.7	15.55	19.24	12.17	7.79	4.72	4.29
Yield (q/ha) 388	341	412	386	469	443	633

Source: DES, MoA, GoI

Table.2 State wise Area, production and yield of small millets and finger millet from 1950-2014.

State / UT	Area (000 ha)	Production (000 tons)	Yield (Kg/ha)	Compound growth rate (%)		
				Area	production	Yield
Andhra Pradesh	30.00 (3.88)	26.00 (6.07)	866.67	-6.01	-1.95	4.31
Arunachal Pradesh	22.09 (2.86)	21.54 (5.03)	975.03	0.67	1.43	0.76
Gujarat	49.00 (6.34)	48.60 (11.35)	991.84	-6.55	-5.82	0.79
Jharkhand	24.95 (3.23)	11.95 (2.79)	478.96	13.58	29.07	13.64
Karnataka	24.21 (3.13)	11.85 (2.77)	489.61	-9.79	-11.10	-1.46
Madhya Pradesh	246.22(31.85)	88.66 (20.71)	360.09	-5.83	-0.86	5.27
Maharashtra	63.00 (8.15)	28.72 (6.71)	455.87	-5.37	-6.89	-1.61
Tamil Nadu	30.84 (3.99)	32.58 (7.61)	1056.62	-7.16	-4.71	2.65
Uttarakhand	71.83 (9.29)	84.38 (19.71)	1174.77	-0.48	-0.20	0.29
All India	773.13 (100)	428.20 (100)	553.85	-5.13	-2.21	3.08

Figure in parenthesis are percentage to all India. Source: DES, MoA, GoI (Redrawn from: Anubukkani *et al*., 2017)

Table.3 Consumption pattern of small millets.

State	All India		Rural		Urban	
	kg / hsh / m	Rs/hsh/m	kg / hsh / m	Rs/hsh/m	kg / hsh / m	Rs/hsh/m
Andhra Pradesh	6.52	80.39	7.06	84.68	1.11	37.86
Assam	18.82	381.96	18.82	381.96	-	-
Bihar	18.69	354.04	18.69	354.04	-	-
Chhattisgarh	4.18	55.14	4.22	55.41	1.97	40.71
Gujarat	0.39	17.82	0.48	19.81	0.36	16.96
Himachal Pradesh	2.00	50.00	2.00	50.00	3.80	47.03
Karnataka	7.12	87.45	8.41	103.37	1.05	119.96
Madhya Pradesh	1.71	96.48	1.88	90.08	0.86	44.89
Maharashtra	1.06	44.31	1.13	44.11	-	-
Orissa	4.06	48.69	4.06	48.69	-	-
Punjab	3.00	60.00	-	-	3.00	60.00
Rajasthan	0.75	30.00	-	-	0.75	30.00
Tamil Nadu	1.77	33.77	2.60	44.12	0.99	24.05
Uttarakhand	4.15	41.02	4.15	41.02	-	-
Uttar Pradesh	4.78	50.01	4.78	50.01	-	-
West Bengal	2.00	160.00	-	-	2.00	160.00

Source: NSSO, MOSPI, GoI. hsh= House hold, m= month

Table.4 Nutritional content in 100 gram of dry grains

Millets	Protein (gram)	Carbo-hyderate (gram)	Fat (gram)	Minerals (gram)	Fiber (gram)	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Energy (Kcal)	Thiamin (mg)	Niacin (mg)
Foxtail	12.3	60.2	4.3	4	6.7	31	290	2.8	351	0.59	3.2
Little	7.7	67	4.7	1.7	7.6	17	220	9.3	329	0.3	3.2
Kodo	8.3	65.9	1.4	2.6	5.2	35	188	1.7	353	0.15	2.0
Porso	12.5	70.4	1.1	1.9	5.2	8.0	206	2.9	354	0.41	4.5
Barnyard	6.2	65.5	4.8	3.7	13.6	22	280	18.6	300	0.33	4.2
Sorghum	10.4	70.7	3.1	1.2	2.0	25	222	5.4	329	0.38	4.3
Pearl	11.8	67	4.8	2.2	2.3	42	240	11	363	0.38	2.8
Finger	7.3	72	1.3	2.7	3.6	344	283	3.9	336	0.42	1.1
Peddy Rice	6.8	78.2	0.5	0.6	1.0	33	160	1.8	362	0.41	4.3
Wheat	11.8	71.2	1.5	1.5	2.0	30	306	3.5	348	0.41	5.1
Quinoa	14	64	6	-	7	36	457	4.6	368	0.36	-

Source: NIN, Hyderbad

Table.5 Proximate composition of millet based cookies

Parameters	Moisture (%)	Crude Protein (%)	Crude Fiber (%)	Crude Fat (%)	Ash (%)	Carbohydrate (%)	Calorific Value (kcal/100gm)
C1	**3.66**	**11.66**	**4.28**	**25.19**	**2.21**	**53.00**	**498**
C2	**3.21**	**12.07**	**4.08**	**26.54**	**2.56**	**50.91**	**503**
C3	**3.16**	**13.22**	**4.72**	**24.06**	**3.16**	**52.32**	**491**

C1(25%Finger Millet+ 25% Pearl Millet+25% Soybean+ 25% Ground nut) C2(15%Finger Millet+ 35% Pearl Millet+25% Soybean+ 25% Ground nut)
C3(35%Finger Millet+ 15% Pearl Millet+25% Soybean+ 25% Ground nut) Radhika *et al.,* (2019)

Table.6 Millet based fermented food products and beverage

Millet Products	Microorganism	Country
Busa (Liquid Beverages)	*Lactobacillus, sacchromyces*	Egypt
Chikokivana (Alcoholic)	*Sacchromyces cerevisiae*	Zimbabwe
Dalaki (ThickHalwa)	Unknown	Nigeria
Doro (Alcoholic drink)	Yeast ,Bacteria	Zimbabwe
Kwanu-Zaki (Liquid Beverages)	LAB, Yeast	Nigeria
Ogi (Liquid Porridge)	*Lactobacillus sp., Aerobacter*	Nigeria
Bogobe (Solid Dough)	*Lactobacillus sp., yeast*	Ghana ,Botswana
Kenkey (Solid Dough)	*Lactobacillus sp., yeast*	Botswana and Ghana
Merissa (Alcoholic)	*Sacchromyces*	Sudan
Mahewu (Liquid Halwa)	*Streptococcus lactis, Lactobacillus delbrukii, L. bulgarius,*	East African
Uji (Halwa)	*Leuconostoc nesenterodes*	Tanganyika,Uganda
Munkoyo (Liquid Beverages)	Unknown	Africa

Source- Blandino *et al.*, 2003 Osungbaro, 2009

Table.7 Health Benefits of Millets

Types of Millets	Health Benefits
Finger millet	Inhibit cataract eye lens, Lower plasma glucose level, Antimicrobial activity against Bacillus cereus and Aspergillus, flavus
Foxtail millet	Anti hyperglycemic activity
Proso millet	Improved HDL, Lower triglycerides, Prevent cardiovascular disease
Kodo millet	Inhibit glycation and cross linking of collagen leads to inhibition of aging
Pearl millets	Inhibiting the growth of the phytopathogenic fungi
Barnyard millets	Improved the levels of HDL
Little millet	Inhibitory effects on lipid peroxidation

Source:Verma *et al.,* (2012) : Fereidoon Shahidi *et al.,* (2013)

Millet–Bakery Products

Millets are gluten free raw material for the cereal industry. The research focused bakery products of amaranth, millets grain and sorghum for the production of bread with functionality and good quality. Amranthus, millet grains and sorghum fortified with wheat

flour have found positive effect on the activation of yeast and dough maturing. The highest grade bread was found by 3 percent mixture of phyto-fortifiers (Volkova *et al.,* 2020). Sorghum, soy and wheat and wheat bread soy1:1 ratio were used in production of biscuits, it contains double protein, 500 to 700 percent lysine and increase 170 percent in-vitro digestibility of protein. The sensory evaluation and texturability of biscuits were acceptable by school going children's. Each 28 gram biscuits give 50 percent daily intake recommended protein to combat the protein energy malnutrition (Serrem *et al.,* 2010).

The wheat and pearl millet mixture prepared for making products like bread, cakes and muffins with good shelf life (Torreset *et al.,* 1993; Suhendro *et al.,* 1998). The studies approved bakery products (biscuits and cakes) was acceptable with the blending of 40 percent wheat and millet flour (Begun *et al.,* 2003 and Yenagi *et al.,* 2013). Radhika *et al.,* showed higher nutritive value of millet based biscuits in table 5.

Millet –Extruded products

Extrusion technology is used for increasing the production of ready to eat products on high temperature short time. The extrusion leads gelatinized starch, denatures protein and inactivate anti nutritional factor then improved digestibility (Roomy and Awaika, 2004). The researcher showed Extruded snacks of composite flour (foxtail millet, rice, chick pea and flex seed) in the ratio of 50:15: 32:3 were acceptable by the sensory attributes (Geetha *et al.,* 2016). The Extruded snacks were produced by composite flour (Sorghum Semoline, finger millets semolina, Foxtail millet semolina, corn semolina, Bengal gram semolina, rice flour and salt) in different blends through the extrusion cooking. The extruded snacks were acceptable by the sensory evaluation (Rao *et al.,* 2018). The noodles were prepared by finger millet flour for diabetic patient. The proportion of finger millet with wheat flour was used 30 to 50 percent. The 30 percent finger millet noodle was lower glycemic index in comparison to control sample (Shukla and Sirvastava, 2011). The finger millet pasta was decrease due to brick red colour of seed coat by the sensory evaluation (Gull *et al.,* 2016). The pasta is mostly made from durum wheat and gives firm desirable texture when cooking and have amber natural colour associated with high quality pasta. Amaranth, buck wheat, lupin flour, millet ingredients have been also used for increasing functional and nutritional quality of pasta and noodles (Shukla and Srivastava, 2011, Devaraju *et al.,* 2008). Radhika *et al.,* (2019) reported that higher nutritional value of millet based steamed pasta.

They contain 9.35 percent moisture, 11.23 percent crude protein, 2.83 percent crude fiber, 5.58 percent crude fat, 5.01 percent ash, 66.00 percent carbohydrate and 372 kcal calorie.

Millet- Traditional Products

Millet is a main component of a meal and consumed by steam cooked products (Thick and thin porridge) for infants and young children in Africa region (Obliana, 2003). Upma is famous traditional food of south India. Pearl millet semolina is used for making upma in spite of wheat semolina. Its sensory and nutritional property is high (Balasubhramaniam *et al.,* 2012). The raga malt formulated drinks are prepared by malt flour with skim milk powder instead of whole milk powder, sugar and flavouring agents. It is highly rich in nutrients and also used for energy drink for all age group (Verma and Patel, 2003). The pearl millet based chapattis, biscuit, instant idli, dhokla was lower glycemic index 48.0 to 58.1 in comparison to

wheat and products (Mani *et al.,* 1993). The nutrients of millets make them suitable for large-scale utilization in the production of food products such as baby foods, snack foods, and dietary food and, increasingly, more millet products have increased into the daily lives of people, such as millet porridge, millet wine, and millet nutrition powder from both grain and flour form (Subramanian and Viswanathan 2007; Liu and others 2012. In India, Idli and dosa are the most widely used as a fermented food. Mostly other fermented foods are also quiet popular and used all over the world because of the importance as human food (Mugocha *et al.,* 2000; Gotcheva *et al.,* 2001). In Africa, koko millet is prepared in the form of fermented millet like porridge and other fermented drink and lactic acid-fermented porridge.

Health Benefits of Millets

Table 7 Shows health benefits of different types of millets.

In present scenario people are very conscious about health. Millets are hidden source for health promoting phytochemicals, and antioxidant as nutraceuticals as well as functional food (Himanshu *et al.,* 2018).

Millets- Diabetes

millets have ability to reducing glucose by enzymatic hydrolysis of complex carbohydrate in hyperglycemia. The aldose reductase enzyme helps in preventing accumulation of sorbitol and decrease the risk of diabetes. Millets also help in controlling sugar level in blood and delay wound healing process (Rajesh Keran N S *et al.,* 2004). The whole grain foods are consumed to be effective for the prevention and management of diabetes mellitus, and showed that millet intake population epidemiologically lower of diabetes (American Diabetes Association 2005; Shobana and others 2009; Kim and others 2011). Some studies find out on humans (male & female) the effect of millet grains and their effect on diabetes. Results showed that persons who has taken millet in diet, found to decrease the level of blood glucose (Pradhan *et al.,* 2010).

Millets – Cancer

Millets are rich in antinutrients such as phenolic, tannins and phytates which help in reducing the risk of cancer. It contains phenolics which effective for the prevention of the cancer initiation and progression (Chandrasekaran, A. *et al.,* 2011). Millets contains linolic acid which helps in preventing tumor (Nobihou *et al.,* 2007). Sorgam has anticarcinogenic properties and antimutagenic property due to presence of tannins and polyphenoals (Grimmer *et al.,* 1992). Millet grains are rich in phenolic acids, tannins, and phytate that act as "antinutrients" (Thompson 1993). A recent study has showed that phenolics of millets may be effective in the prevention of cancer initiation and progression in vitro (Chandrasekara and Shahidi 2011).

Millets – Celiac disease

Celiac disease is a genetically problem associated with consumption of gluten one of the component of cereal grain mainly in wheat. Millets are gluten free which help to decrease irritation of other cereal grains (Saleh *et al.,* 2013). Millets are gluten-free foods and beverages that can be suitable for celiac disease person. (Taylor and others 2006; Taylor and Emmambux 2008; Chandrasekara and Shahidi 2011, 2011).

Millets – Heart Disease

Millets are good source of magnesium which helps in reducing heart attack. Millets are rich in phyto-chemicals which help in lowering

cholesterol and prevent cardio vascular disease (Lee *et al.,* 2010). Millets have a good source of protein and essential amino acid, micronutrient and phytochemicals. It plays significant role as health promoter and also help in preventing diabetes, hyperlipidaemia, etc. (Veena, 2003).

The millets are considered as nutraceutical due to its amazing nutritive value and health benefits over other cereals. Millets based pasta, biscuits, cakes, weaning food, fermented food and traditional products are available in market with reasonable price. The aim of study is to awake the people to reorganize the importance of millets as nutritious food and full-fill the nutritional need of population and also increase demand and consumption of millets in daily meal. Millets are nutritionally effective and can reduce the problem of malnutrition and other health related problems.

Acknowledgement

We are very thankful to our institute and supervisor who support for my work.

References

Ali MAM, El Tinay A. H., Abdalla A. H. (2003). Effect of fermentation on the *in-vitro* protein digestibility of pearl millet. *Food Chem.* 80(1): 51– 54.

American Diabetes Association. 2005. Diagnosis and classification of diabetes mellitus. Diabet Care 28:37–42.

Anubukkani, P.; Balaji, S. J. and Nithyashree, M. L. (2017). Production and consumption of minor millets in India- A structural break analysis. *Ann. Agric. Res. New Series* 38(4):1-8.

Arora S, Jood S & Khetarpaul N. Effect of germination and probiotic fermentation on nutrient profile of pearl millet based food blends. Br. Food J. 2011; 113(4): 470-81

Balasubramanian S., Yadav, D. N., Kaur, J. and Anand, T. (2012). Development and shelf-life evaluation of pearl millet based upma dry mix. Food Sci Tech. J. DOI: 10.1007/s13197-012-0616-0.

Begum, J. M., Vijaya Kumari, Begum, S., Pandy, A., Shivaleela, H. and Meena Kumari. (2003). Nutritional composition and sensory profile of baked products from finger millet.). *In: Recent* 45: 97–102.

Blandino, A., Al-Aseeri, M. E., Pandiella, S. S., Cantero, D. and Webb, C. (2003). Cereal-based fermented foods and beverages. *Food Research International*, 36(6), 527-543. http://dx.doi.org/10.1016/ S0963-9969(03)00009-7.

Chandra, Anjali. Singh, Ajeet Kumar and Mahto, Bharat (2018). Processing and Value Addition of Finger Millet to Achieve Nutritional and Financial Security. *International Journal of Current Microbiology and Applied Sciences. 2319-7706* Special Issue-7. 2901-2910

Chandrasekara A, Shahidi F. 2011b. Antioxidant phenolics of millet control lipid peroxidation in human ldl cholesterol and food systems. J Am Oil ChemSoci DOI: 10.1007/s11746-011-1918-5. Available from Springer [http://www.springerlink.com]. Posted August 20, 2012

Chandrasekara A, Shahidi F. 2011c. Antiproliferative potential and DNA scission inhibitory activity of phenolics from whole millet grains. J Funct Foods 3:159–70

Chandrasekara, A. and Shahidi, F. (2012). Bioaccessibility and antioxidant potential of millet grain phenolics as affected by simulated in vitro digestion and microbial fermentation. *J Funct Foods* 4: 226– 37

Chethan S. and Malleshi, N. G. (2007). Finger millet polyphenols: optimization of extraction and the effect of pH on their stability. *Food Chem.* 105(2): 862– 870.

Chowdhury S, Punia D. 1997. Nutrient and antinutrient composition of pearl millet grains as affected by milling and baking. Nahrung 41(2): 105–7

Coulibaly A, Kouakou B & Chen J. Phytic Acid in Cereal Grains: Structure, Healthy or Harmful Ways to Reduce Phytic Acid in Cereal Grains and their Effects on Nutritional Quality. Am. J. Plant Nutr. Fert. Technol. 2011; 1: 1–22

Dayakar, Rao, B. Ganapathy, K. N. and Patil, J. V. (2013).Sorghum/ Millets: Small Grains, A big Grain, www.commodity.com

Devaraju B, Begum M, Begum S and Vidya K. 2006. Effect of temperature on physical properties of pasta from finger millet composite flour. Journal of Food Science and Technology, 43: 341-343.

Glew, R. S., Chuang, L.T., Roberts, J. L. and Glew, R. H. (2008). Amino acid, fatty acid and mineral content of black finger millet (*Eleusinecoracana*) cultivated on the Jos Plateau of Nigeria. *Food* 2(2): 115– 118.

GoI (various issue). Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi

GoI. 2011. Agricultural statistics at a glance, Department of Economics and Statistics, Government of India, (http:// www.dacnet. in/eands, Accessed on 15 Feb, 2016)

Gotcheva V, Pandiella SS, Angelov A, Roshkova Z, Webb C. 2001. Monitoring the fermentation of the traditional Bulgarian beverage boza. Intl J Food SciTechnol 36: 129–34.

Gull, A., Jan, R., Nayik, G. A., Prasad, K., & Kumar, P. (2014). Significance of finger millet in nutrition, health and value added products: a review. *Journal of Environmental Science, Computer Science and Engineering and Technology*, 3(3), 1601-1608.

Hassan A B, Ahmed I A M, Osman N M, Eltayeb M M, Osman G A, Babiker E E. Effect of processing treatments followed by fermentation on protein content and digestibility of pearl millet (*Pennisetumtyphoideum*) cultivars. Pakistan J Nutr. 2006; 5(1): 86–9.

Hulse, J. H., Laing, E. M. and Pearson, O. E. (1980). Sorghum and the millets: their composition and nutritive value. New York: Academic Press. p 1–997.

ICAR - Indian Institute of Millets Research, 2017 (IIMR)

Issoufou, Amadou; Elhadji Gounga, Mahamadou and Guowei, Le. (2013).Millets: Nutritional composition, some health benefits and processing - A Review. *Emirates Journal of Food and Agriculture*25(7):501-508.

Kalinova, J. and Moudry, J. (2006). Content and quality of protein in proso millet *(Panicummiliaceum L.)* varieties. *Plant Foods Hum. Nutr.* 61: 45– 49.

Kim J S, Hyun T K, Kim M J. 2011. The inhibitory effects of ethanol extracts from sorghum, foxtail millet and proso millet on α-glucosidase and a-amylase activities. Food Chem 124:1647–51

Kimeera, Ambati and Sucharitha, K. V. (2019).Millets-Review on Nutritional Profiles and Health Benefits. *International Journal of Recent Scientific Research. 10, Issue, 07(I), pp. 33943-33948.*

Lee, S. H.; Chung, I M. Cha, Y S. and Parka, Y. (2010). Millet consumption decreased serum concentration of triglyceride and C reactive protein but not oxidative status in hyperlipidemic rats. *Nutr Res.* 30: 290– 296.

Lei V & Jacobsen M. Microbiological Characterization and Probiotic Potential of Koko and Koko Sour Water, African Spontaneously Fermented Millet Porridge and Drink. J. Applied Microbiol. 2004; 96: 384–397.

Lei V, Friis H & Michaelsen K F. Spontaneously Fermented Millet Product as a Natural Probiotic Treatment for Diarrhea in Young Children: An Intervention Study in Northern Ghana. Int. J. Food Microbiol. 2006; 110: 246–253

Lestienne I, Mouquet-Rivier C, Icard-Verniere C, Rochette I, Treche S. The effects of soaking of whole, dehulled and ground millet and soybean seeds on phytate degradation and Phy/Fe and Phy/Zn molar ratios. Intl J Food Sci Technol. 2005; 40: 391–9.

Liu J, Tang X, Zhang Y, Zhao W. 2012. Determination of the volatile composition in brown millet, milled millet and millet bran by gas chromatography/ mass spectrometry. Molecules 17:2271–82. Liu RH. 2007. Whole grain phytochemicals and health. J Cereal Sci 46:207–19.

Mal, B., Padulosi, S. and Ravi, S. B. (2010). Minor millets in South Asia: learnings from IFAD-NUS Project in India and Nepal. Maccarese, Rome, Italy: Bioversity Intl and Chennai, India: M.

Malik, Shweta (2015) Pearl Millet-Nutritional Value and Medicinal Uses (Food & Nutrition) Dept. of Home

Mani, U. V., Prabhu, B. M., Damle, S. S. and Mani, I. (1993). Glycemic index of some commonly consumed foods in western India. *Asia Pacific J. ClinNutr*. 111–114.

Mohamed, T. K., Zhu, K., Issoufou, A., Fatmata, T. and Zhou, H. (2009). Functionality, in vitro digestibility and physicochemical properties of two varieties of defatted foxtail millet protein concentrates. *International J. Molecular Sci*. 10: 522– 538.

National Institute of Nutrition 2003; Indian Foods Nutritional Value.

NSSO. 2012. Household Consumer Expenditure' 68th round, Ministry of Statistics and Progrmme Implementation, GoI.

Obilana, A. B. (2003). Overview: importance of millets in Africa. In: Belton P S, Taylor J R N, editors. Proceeding of the Workshop on the Proteins of Sorghum and Millets: Enhancing Nutritional and Functional Properties for Africa. 2–4 April 2003. Pretoria, South Africa. Available from <http://www.afripro.org.uk>. Accessed July 2004.

Osungbaro, T. O. (2009). Physical and nutritive properties of fermented cereal foods. *African Journal of Food Science* 3(2): 23-27.

Palanisamy Bruntha Devi, Rajendran Vijayabharathi, Sathyaseelan Sathyabama, Nagappa Gurusiddappa Malleshi, Venkatesan Brindha Priyadarisini, (2014), Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review, Journal of Food Science and Technology, 51(6):1021-1040

Parameswaran, K. and Sadasivam, S. (1994). Changes in the carbohydrates and nitrogenous components during germination of proso millet (*Panicummiliaceum*). *Plant Foods Hum Nutr*

Radhika, Virk Amreen, Kaur Manpreet, Thakur Priyanka, Chauhan Divya, Rizvi Quart UlEainHyder, Jan Sumira and Kumar Krishan. (2019). Development and Nutritional Evaluation of Multigrain Gluten free cookies and pasta products. Current Research in Nutrition and Food Science. Vol (7) 3 842-843

Ragaee, S., Abdel Aal, E. M. and Noaman, M. (2006). Antioxidant activity and nutrient composition of selected cereals for food use. *Food Chem* 98(1): 32– 8.

Rajasekaran, N. S., Nithya, M., Rose, C. and Chandra, T. S. (2004). The effect of finger millet feeding on the early responses during the process of wound healing in diabetic rats. *BiochimBiophysActa* 1689(3–4): 190–201.

Reddy, O. S. K. (2017). Smart Millet and Human Health, *Green Universe Environmental Services Society*.

Rooney, L. W. and Awika, J. M. (2004). Specialty sorghums for healthful foods. In: Abdelaal E, Wood P, editors. Specialty grains for food and feed. St Paul, Minn.: AACC. P 238–312. S. Swaminathan Research Foundation. p 1–185.

Saleh, A. S. M., Zhang, Q., Chen, J. and Shen, Q. (2013). Millet Grains: Nutritional Quality, Processing, and Potential Health Benefits. *Comprehensive Reviews in Food Science and Food Safety*, 12:281-295 September 13, 2011.Science, B.P.S. Women's University Khanpur Kalan(Hry) *www.ijariie.com*, Vol-1 Issue-3

Sarita and Singh, Ekta. 2016. Potential of Millets: Nutrients Composition and Health Benefits. Journal of Scientific and Innovative Research 2016; 5(2): 46-50

Shahidi, F., & Chandrasekara, A. (2013). Millet grain phenolics and their role in diseases risk reduction and health promotion – review. Journal of Functional Foods, 5(2), 570-581. http://dx.doi.org/10.1016/j. jff.2013.02.004.

Shobana S, Krishnaswami K, Sudha V, Malleshi N G, Anjana R M, Palaniappan L & Mohan V. Finger Millet (Ragi, *Eleusine coracana* L.): A Review Of Its Nutritional Properties, Processing, and Plausible Health Benifits. Advance in Food and Nutrition Research. 2013; 69: 1-3.

Shukla, K. and Srivastava, S. (2011). Evaluation of finger millet incorporated noodles for nutritive value and glycemic index. *J Food SciTech*.DOI: 10.1007/s13197-011-0530-x. Posted

Singh, P.; Singh, G.; Srivastava, S. and Agarwal, P. (2005). Physico-chemical characteristics of wheat flour and millet flour blends. *Journal of Food Science and Technology*, 42 (4):340-343.

Soumya Rathore, Karunakar Singh, Vivek Kumar.2016. Millet Grain Processing, Utilization and Its Role in Health Promotion: A Review. International Journal of Nutrition and Food Sciences 2016; 5(5): 318-329 http://www.sciencepublishinggroup.com/j/ijnfs doi: 10.11648/j.ijnfs.20160505.12 ISSN: 2327-2694 (Print); ISSN: 2327-2716 (Online)

Sripriya, G., Antony, U., and 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(4), 345-350

Subramanian S, Viswanathan R. 2007. Bulk density and friction coefficients of selected minor millet grains and flours. J Food Eng 81(1):118–26.

Suhendro, E. L., McDonough, C. M, Rooney, L. W., Waniska, R. D. and Yetneberk, S. (1998). Effects of processing conditions and sorghum cultivar on alkaline-processed snacks. *Cereal Chem.* 75: 187–193.

Taylor J R N, Emmambux M N. 2008. Gluten-free foods and beverages from millets. In: Gallagher E, editor. Gluten-free cereal products and beverages. Burlington, MA: Elsevier. p 1–27.

Taylor J R N, Schober T J, Bean S R. 2006. Novel food and non-food uses for sorghum and millets. J Cereal Sci 44(30):252–71.

Thompson L V. 1993. Potential health benefits and problems associated with antinutrients in foods. Food Res Intl 26:131–49.

Torres PI, Ramirez-Wong B, Serna-Saldivar S O, Rooney L W. 1993. Effect of sorghum flour addition on the characteristics of wheat flour tortillas. Cereal Chem 70 (1): 8–13.

Trends in Millet Processing and Utilization, CCS HisarAgril.Univ., Hisar, India, pp: 82-87.

Upadhyaya, H. D., Ramesh, S., Sharma, S., Singh, S. K., Varshney, S. K., Sarma, N. D. R. K., Ravishankar, C. R.; Narasimhudu, Y.; Reddy, V. G.; Sahrawat, K. L.; Dhanalakshmi, T. N.; Mgonja, M. A.; Parzies, H. K.; Gowda, C. L. L. and Singh, S. (2011). Genetic diversity for grains nutrients contents in a core collection of finger millet, *Eleusine coracana* L. germplasm. *Field Crops Research*, 121(1), 42-52.

USDA. (2000). Dietary guidelines for Americans. US Government Printing Office. US Department of Agriculture, Department of Health and Human Services. Washington, DC.

Veena, B. (2003). Nutritional, functional and utilization studies on barnyard millet. *M. Science Thesis, University of Agricultural Sciences, Dharwad (Karnataka), India*

Verma, Veenu and Patel, S. (2012), Nutritional security and value added products from finger millets (ragi), Journal of Applicable Chemistry, 1 (4):485-489

Yenagi, N.; Joshi, R.; Byadgi, S. and Josna, B. (2013). A hand book for school children: Importance of Millets in Daily Diets for Food and Nutrition Security. *University of Agricultural Sciences, Dharwad, India*, pp. 1-24.

How to cite this article:

Pragya Mishra, H. G. Prakash, Suman Devi, SeemaSonkar, Shweta Yadav, H. C. Singh and Singh, D. R. 2021. Nutritional Quality of Millets and their Value Added Products with the Potential Health Benefits: A Review. *Int.J.Curr.Microbiol.App.Sci.* 10(10): 163-175.
doi: https://doi.org/10.20546/ijcmas.2021.1010.019