



A REVIEW ON MILLETS (KSHUDRA DHANYA): NUTRITIONAL AND HEALTH BENEFITS IN LIFESTYLE DISEASES

DEBAJYOTI DAS^{1*} DIPSUNDAR SAHU² SAROJ KUMAR DEBNATH³ RANJITAEKKA⁴ TUSHAR KANTI MANDAL⁵ G BABU⁶

^{1*2,3,4} Research Officer (Ayurveda), Central Ayurveda Research Institute, Kolkata, West Bengal, India, Central Council for Research in Ayurvedic Sciences, Ministry of AYUSH, Government of India.

⁵ Assistant Director (Ayurveda), Central Ayurveda Research Institute, Kolkata, West Bengal, India, Central Council for Research in Ayurvedic Sciences, Ministry of AYUSH, Government of India.

⁶ Director (Ayurveda), Central Ayurveda Research Institute, Kolkata, West Bengal, India, Central Council for Research in Ayurvedic Sciences, Ministry of AYUSH, Government of India.

Corresponding Author Email: debajyoti.das02@gmail.com Access this article online: www.jahm.co.in

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ABSTRACT:

In present scenario the incidence of lifestyle disorders like, obesity, diabetes mellitus, asthma, osteoporosis, some types of cancer and cardiovascular diseases etc. are more prevalent across all sections of the society. Millets are considered as a viable option to live healthy life and can reduce the incidence of various lifestyle disorders. The millets are known as miracle nutri-cereals due to their superior nutritional qualities compared to other major cereals. Millets are gluten-free proteins with a low glycemic index, high fiber content and richness in protein, micro-nutrients and bioactive compounds and hence providing various health benefits. In Ayurvedic text millets have been described in the name as Kshudra Dhanya (small-sized grains), Trina Dhanya (grass-derived grains) and Kudhanya (Inferior among grains) etc. The qualities, mode of actions and indications of Kshudra Dhanya (millet) may help to reduce lifestyle diseases. This review is focused to evaluate the nutritional and medicinal efficacy of millets to combat lifestyle diseases for document a good reference for further research on millets to develop the novel drugs for society.

KEYWORDS: Millets, *kshudra dhanya*, nutritional and health benefits, lifestyle diseases

INTRODUCTION

Lifestyle diseases are the major concern of present time and it is mostly related to the sedentary lifestyle with unhealthy dietetic habit. Such a lifestyle habit can further lead to several chronic non-communicable diseases with having near life-threatening consequences. The main causative factors which induces lifestyle diseases for prolonged exposure to physical inactivity, wrong body posture, unhealthy diets, wrong sleeping patterns, excess intake of tobacco and alcohol, high stress levels etc., which can lead to cerebrovascular diseases, chronic lung diseases, chronic liver diseases, obesity, type 2 diabetes etc. Around 74% of death globally is considered to be as a result of Non-communicable diseases (NCDs) and it is also one of the leading causes of death^[1]. In 2021, Near about 41 million death occurred from NCDs globally, which includes 44% cardiovascular diseases, 23% cancer, 10% chronic respiratory diseases, and 4%diabetes mellitus^[2]. Unhealthy dietetic habit, physical inactivity and tobacco addiction etc. are reported as major risk factors for non-communicable diseases^[3]. *Ahara* (diet) is considered the most important pillar of health in Ayurveda and it is very important to sustain life and maintaining normal physiological function of human body. Ayurveda emphasizes the importance of a

balanced diet for maintaining good health. In Ayurveda, millets contributed as one of the most important cereal grains for human nutrition.

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The present study thus aimed to understand the current trend in area, production.

productivity and consumption of millets in India.

Millets are ancient grains that have been cultivated and consumed by humans for thousands of years in many parts of the world. For example, finger millet was in use since 5000 years ago in Africa^[4]; pearl millet around 4000 years ago^[5]; and foxtail millet was 8000 years ago^[6]. Millet belongs to the family Poaceae, which are drought and pest resistant crops grown in dry and arid regions, high-temperature conditions as a group of small seeded grasses and has been explored as human as well as livestock food for around 10,000 years^[7]. Millets are the world's sixth most important cereal grain and is considered as a major source of nutrients, which provides nutritional support to millions of people in India, Africa, and China^[8]. Millets are primarily

grown in Asia and Africa and India is the largest producer followed by Nigeria and China^[9]. In rural areas, some millets, such as finger millets and Sorghum are consumed as food, while the remainder is used as animal feed. Millets are consumed by more than 1/3rd of the world's population. India fulfils 80% of the global millet production and demand considered as the largest producer of millets. Sorghum and pearl millets are most widely grown crops in India and parts of Africa. Generally, finger millet (*Eleusine coracana*) and pearl millet (*Pennisetum glaucum*) are considered as the two major millets used as food article. Pearl millet is having highest production among millets followed by sorghum and finger millet in India^[10]. The United Nations General Assembly (UNGA) adopted a resolution declaring 2023 as the International Year of Millets^[11]. The Ministry of Agriculture and Farmers Welfare has well recognized the importance of Millets because they provide maximum nutrients than other grains in cereal category. For production, consumption and trade point of view the Ministry declared millets comprising Sorghum (*Jowar*), Pearl millet (*Bajra*), Finger millet (*Ragi/ Mandua*), Minor millets, i.e. Foxtail millet (*Kangani/ Kakun*), Proso millet (*Cheena*), Kodo millet (*Kodrava*) Barnyard millet (*Sawa/Jhangor*), Little millet (*Kutki*) and two

Pseudo millets, i.e. Buck wheat (*Kuttu*) and Amaranthus (*Chaulai*) as "Nutri-cereals".

Millets have been employed in Ayurveda as a food of both healthy and diseased condition. In Ayurveda millets have been explained as *Kudhanya* (Inferior among grains), *Kshudra Dhanya* (small-sized grains), and *Trina Dhanya* (grass-derived grains) etc.^[12]. In *Charak Samhita* millets are mentioned in *Dhanyavarga* like *Shyamak* and *Koradusha*. Various other *Samhitas* also mentioned millets. In *Bhavaprakasha nigantu* these are explained as *kshudradhanya* having *kashaya* and *madhura rasa, ushna, ruksha, laghu, katu vipaka, vatakara, lekhan,* and *grahi* and also decrease *pitta* and *kapha*^[13].

The purpose of this article is to provide brief information on millets with its all nutritional and health benefits in order to reduce life style diseases in relation to Ayurveda with perspective of modern scientific studies and to promote their use as staple diet in future.

2. MATERIALS AND METHODS

A thorough review of the Ayurvedic literature and electronic search was conducted on Ayush Portal, Research Gate, PubMed, Scopus, Google Scholar and Web of Science etc. for collecting authentic data on nutritional and health benefits of millets to combat life style diseases. All collected databases were analysed and compiled over lifestyle disorders.

2.1. Nutritional value of Millets

The millets are known as miracle nutri-cereals due to their superior nutritional qualities compared to other major cereals^[14]. Millets are rich in calcium, zinc, magnesium, potassium, iron, phosphorus, vitamin B and essential amino acids. They also contain high amounts of proteins, niacin, thiamine, riboflavin, folic acid the essential sulphur-containing amino acid methionine, lecithin, and vitamin E^[15]. Millets have gained popularity because they are gluten-free and reservoir of high protein, fiber, and antioxidant contents, provide more essential aminoacids than most other cereals. Millets provide nutrient-rich foods that can be utilised in malnutrition-affected infants, children, old age population and women of reproductive age^[16]. Millets' polyphenols (0.2-0.5%), tannins, and phytates provide the bulk of their antioxidant activity and these substances have a role in regulating the aging process. In developing countries, millets specially sorghum contribute greatly to nutritional security. There is an abundance of iron in Pearl Millet and Barnyard Millet, which can fulfill the iron requirement of anemic individuals. The iron content of barnyard millet is 17.47 mg/100 g which is almost equal value to daily required dose only 10 mg lower than the required value. Foxtail millet is rich source of zinc as well as iron, which contains highest

amount of zinc (4.1 mg/100 g) and 2.7 mg/100g of iron^[17]. There is a high content of zinc (4.1 mg/100 g) in foxtail millet, as well as a high content of iron ^[18]. Finger millets is rich in higher levels of minerals like Ca, Mg, and K^[15]. Pearl millet contain high levels of Fe, Zn, and lysine (17–65 mg/g of protein) as compared to other millets^[19]. Pearl millets contain higher concentrations of minerals such as calcium, phosphorus, magnesium, manganese, zinc, iron, and copper etc. than corn^[20]. Calcium content of Pearl millet contains high level of calcium ranges from 45.6 to 48.6 mg/100 g^[21] and also has rich in phosphorus, which is an important mineral in the mineral matrix of bone and adenosine triphosphate (ATP) which is the energy booster in the body. Finger millet is rich in calcium as compared to other cereals which ranges from 162 mg/100 g to 487 mg/100 g^[22]. Barnyard millet is the richest source of Fe (18.6 mg/100g dry matter) and crude fiber (13.6%) whereas porso millet contains the highest amount of proteins (12.5%)^[19]. Pear millet contain about 11.6% protein, which is higher than protein contain in rice i.e 7.2%, 11.5% protein found in barley, 11.1% found in maize and 10.4% protein present in sorghum^[23]. Finger millet contain many essential amino acids such as lysine, threonine, and valine as compared to other millet varieties^[24]. In addition, millets contain

huge amount of magnesium, which is believed to have the ability fight the disease like cancer. Reported that magnesium content of 84.71 mg/100 g to 567.45 mg/100 g is found in finger millet^[25]. Protein contain in Finger millet is rich in essential amino acids (44.7%) such as methionine, lysine and valine^[26] and the amount of essential amino acids like leucine, isoleucine and thiamine is very higher in proso millet. The mineral content in millets ranges from 1.6 to 4.7 g/100 g, which is much higher than mineral content of wheat (1.5%) and rice (0.6%). The nutrients content like zinc

and iron, play an important role to boost the immunity. The thiamine and niacin content of millets is comparable to that of rice and wheat. The highest thiamine content is found in foxtail millets i.e. 0.59 mg/100 g. Riboflavin content of the proso millet is much higher than the staple cereals i.e. 0.28 mg/100 g and is the highest content of riboflavin followed by pearl millet i.e 0.21 mg/100 g. The details of nutrient content of various millets has been discussed in following tables. The inclusion of millets along with regular diet can help to maintain the proper nutrition.

Table 1: Nutrient contents in various cereals

Cereal (per 100g)	Protein (g)	Carbo hydrates (g)	Fat (g)	Crude fibre (g)	Mineral matter (g)	Calcium (mg)	Phosphorus (mg)	Iron ^a (mg)
Sorghum	10.4	72.6	1.9	1.6	1.6	25	222	5.4
Pearl millet	11.6	67.5	5.0	1.2	2.3	42	296	11.0
Finger millet	7.3	72.0	1.3	3.6	2.7	344	283	3.9
Barnyard millet	11.6	74.3	5.8	14.7	4.7	14	121	18.6
Proso millet	12.5	70.4	1.1	2.2	1.9	14	206	2.9
Foxtail millet	12.3	60.9	4.3	8.0	3.3	31	290	2.8
Kodo millet	8.3	65.9	1.4	9.0	2.6	27	188	1.7
Little millet	8.7	75.7	5.3	8.6	1.7	17	220	9.3
Maize	11.5	66.2	3.6	2.7	1.5	20	348	2.7
Wheat	11.8	71.2	1.5	1.2	1.5	41	306	3.5
Rice	6.8	78.2	0.5	0.2	0.6	10	160	1.8

Source: National Institute of Nutrition, Hyderabad

a. Iron content is taken from: Hulse, et al., 1980; United States National Research Council/National Academy of Sciences, 1982; USDA/HNIS, 1984. The rice mentioned is brown rice.

Table2: Micronutrient profile of various cereals (mg/100g)

Cereal	Mg	Na	K	Cu	Mn	Mb	Zn	Cr	Su	Cl
Foxtail millet	81	4.6	250	1.40	0.60	0.070	2.4	0.030	171	37
Proso millet	153	8.2	113	1.60	0.60	-	1.4	0.020	157	19
Finger millet	137	11.0	408	0.47	5.49	0.102	2.3	0.028	160	44
Little millet	133	8.1	129	1.00	0.68	0.016	3.7	0.180	149	13
Barnyard millet	82	-	-	0.60	0.96	-	3	0.090	-	-
Kodo millet	147	4.6	144	1.60	1.10	-	0.7	0.020	136	11
Sorghum	171	7.3	131	0.46	0.78	0.039	1.6	0.008	54	44
Bajra	137	10.9	307	1.06	1.15	0.069	3.1	0.023	147	39
Rice	90	-	-	0.14	0.59	0.058	1.4	0.004	-	-
Wheat	138	17.1	284	0.68	2.29	0.051	2.7	0.012	128	47

Source: Nutritive value of Indian foods, NIN, 2007

Table 3: Vitamin profile of Millets (mg/100g)

Cereal	Vit.B1	Vit.B3	Vit.B2	Vit.A	Vit.B6	Folic Acid	Vit.B5	Vit.E
Foxtail millet	0.59	3.2	0.11	32	-	15.0	0.82	31.0
Proso millet	0.41	4.5	0.28	0	-	-	1.2	-
Finger millet	0.42	1.1	0.19	42	-	18.3	-	22.0
Little millet	0.3	3.2	0.09	0	-	9.0	-	-
Barnyard millet	0.33	4.2	0.1	0	-	-	-	-
Kodo millet	0.15	2.0	0.09	0	-	23.1	-	-

Sorghum	0.38	4.3	0.15	47	0.21	20.0	1.25	12.0
Bajra	0.38	2.8	0.21	132	-	45.5	1.09	19.0
Rice	0.41	4.3	0.04	0	-	8.0	-	-
Wheat	0.41	5.1	0.1	64	0.57	36.6	-	-

Source: Nutritive value of Indian foods, NIN, 2007

2.2. Health benefits of millets

Sedentary lifestyle and food habits are the primary cause of diabetes, obesity and cardiovascular diseases. Therefore, dietary modification is an important measure to prevent and protect all lifestyle disorders. Millets are gluten-free proteins with a low glycaemic index, high protein, high fibre content and richness in bioactive compounds that are betterment for health. The presence of phyto-nutrients and phytic acid in millets is believed to lower cholesterol and phytate, which is involved in reducing risk of cancer. Millets are rich in fiber and non-starchy polysaccharides that control blood glucose level and also rich in phenolic compounds, that act as antioxidants to prevent or reduce the damage caused by oxidation and plays an important role to boost the immune system^[27]. Among the all millets Foxtail millet having lowest carbohydrate is recommended as an ideal choice of food for type II diabetes^[28]. The highest dietary fibre present in barnyard millet and kodo millet is effective for patients of diabetis mellitus. In vitro studies of the soluble polysaccharides of finger millet (arabinose and xylose mainly) are

proved to be potent prebiotics and it also possess wound dressing potential ^[29]. The studies shows that finger millets lowers the blood glucose as well as cholesterol level and it has also anti-ulcerative and wound healing properties^[30]. Barnyard millet and pearl millet are the rich source of iron, and their consumption helps in condition of anaemia. Barnyard millet is an ideal food for lifestyle diseases and for anaemic patients mainly to the women in developing countries^[31]. Magnesium present in great millet, is important to nerve function, muscle contraction, normal heart rhythm, regulating blood pressure and aids in easing asthmatic patients' breathing issues. The fiber in pearl millets contributes to a decrease in the occurrence of gallstones^[32]. Finger millet helps lactating mothers produce sufficient breast milk^[32]. Furthermore, millets are naturally gluten free and provide an option to those who have celiac disease or gluten intolerance^[33]. Calcium content in finger millet is about three fold higher than milk and 10 times higher than wheat, maize and brown rice^[34]. and hence, it acts to prevent osteoporosis and strengthens bone health and

teeth which reduces the chance of bone fractures. Kodo millet is excellent for strengthening the nervous system as it contains a high amount of lecithin^[35]. Additionally, millet may help to reduce cholesterol levels, coronary heart disease, risk of stroke, liver disease and certain cancer through the antioxidant activity^[36]. Millets also have an anti-hypertensive effect as a result of inhibition of serum ACE activity^[37]. It is also well reported that millet significantly

reduces body weight as it contains more fiber, antioxidants, and phenolic compounds which^[38] which are helpful in obesity. Millet fibre may help to reduce bad cholesterol and boosting good cholesterol. It also reduces the secretion of bile acids, which causes gallstones in the body^[39] but it is important for gut health^[40] heart disease, colon cancer and diabetes^[41]. Dietary fibre also reduces the blood glucose level due to its slower digestive property which is useful in diabetic patients^[42].

Table 4: Therapeutic uses of millets in Ayurveda^[43].

Name of Millets	Botanical Name	Action & Therapeutic uses
<i>Shyamaka</i> (Barnyard Millet)	Echinochloa frumentace Linn.	<i>Kaphapittahara</i> (pacify <i>kapha</i> & <i>pitta dosha</i>), <i>sangrahi</i> (absorbs excessive fluids from intestine and helps for natural compactness of stool and enhances digestion), <i>dhatu shosan</i> (dries up excessive moisture in tissues) , <i>lekhaniya</i> (scraping), <i>sthoulya</i> (obesity), <i>medoroga</i> (diseases due to excessive lipids), <i>prameha</i> (diabetes mellitus).
<i>Kodrava</i> (Kodo Millet)	Paspalum scrobiculatum Linn.	<i>Vatakar</i> (aggravates <i>vata dosha</i>), <i>grahi</i> (absorbs excessive fluids from intestine and helps for natural compactness of stool and enhances digestion), <i>shosaka</i> (dries up excessive moisture) , <i>lekhaniya</i> (scraping), <i>sthoulya</i> (obesity), <i>medoroga</i> (diseases due to excessive lipids), <i>prameha</i> (diabetes mellitus), <i>raktapitta</i> (bleeding disorders), <i>vishahara</i> (anti-poisonous).
<i>Gavedhuk</i> (Adlay)	Coix lacryma jobi Linn.	<i>Kaphahara</i> (pacify <i>kapha dosha</i>), <i>karshyakari</i>

Millet)		(promotes emaciation), <i>sangrahi</i> (absorbs excessive fluids from intestine and helps for natural compactness of stool and enhances digestion), <i>dhatu shosan</i> (dries up excessive moisture in tissues) , <i>lekhaniya</i> (scraping), <i>sthoulya</i> (obesity), <i>medoroga</i> (diseases due to excessive lipids), <i>prameha</i> (diabetes mellitus).
<i>Kangu</i> (foxtail Millet)	<i>Setaria italica</i> Beauv.	<i>Sangrahi</i> (absorbs excessive fluids from intestine and helps for natural compactness of stool and enhances digestion), <i>dhatu shosan</i> (dries up excessive moisture in tissues), <i>brimhan</i> (nourishes the body tissues), <i>bhagnasandhankar</i> (fracture healing), <i>sthoulya</i> (obesity), <i>prameha</i> (diabetes mellitus), <i>twakvikar</i> (skin disorders), <i>amavata</i> (rheumatoid arthritis), <i>asthi bhagna</i> (fracture of bone)
<i>Cheenaka</i> (Proso Millet)	<i>Panicum miliaceum</i> Linn.	<i>Kaphahara</i> (pacify <i>kapha dosha</i>), <i>brimhan</i> (nourishes the body tissues), <i>bhagnasandhankar</i> (promotes fracture healing), <i>sthoulya</i> (obesity), <i>medoroga</i> (diseases due to excessive lipids), <i>prameha</i> (diabetes mellitus).
<i>Yavanaala/Jowar</i> (Sorghum/Great Millet)	<i>Sorghum vulgare</i> pers.	<i>Kaphapittahara</i> (pacify <i>kapha</i> and <i>pitta dosha</i>), <i>trishnaghna</i> (pacify excessive thirst), <i>mutrala</i> (diuretic), <i>vrishya</i> (aphrodisiac), <i>sthoulya</i> (obesity), <i>prameha</i> (diabetes mellitus), <i>raktapitta</i> (bleeding disorders).
<i>Nartiki/ Ragi</i> (Finger Millet)	<i>Eleusine coracana</i> Linn.	<i>Balya</i> (promotes strength), <i>vrishya</i> (aphrodisiac), <i>raktapitta</i> , <i>sthoulya</i> (obesity), <i>prameha</i> (diabetes mellitus), <i>twakvikar</i> (skin disorders).

<i>Bajra</i> (pearl Millet)	Pennisetum typhoides Burm.f.Stapf. & Habbard	<i>Balya</i> (promotes strength), <i>agnimandya</i> (loss of appetite), <i>strikamodpadaka</i> (aphrodisiac).
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RESULT AND DISCUSSION

Nowadays the incidence of lifestyle diseases like diabetes mellitus, hypertension, dyslipidaemia, obesity, cancer and cardiovascular diseases are continuously increasing day by day due to the disturbed pattern of life style. These diseases are comes under the *santarpanjanya vyadhi* (diseases due to over nourishment) as the result of *medovaha srotodusti* in Ayurveda. The *guru guna* of millets takes very long time to undergo digestion due to presence of more amounts of dietary fibre and protein. Both *lekhana* (scraping) & *shoshan* (dries up excess moisture) properties of millets are effective to correct *medodushti* (disorders of fat metabolism) in the treatment of *santarpanjanya vyadhi* by reducing excess fat in obesity, dyslipidemia, type 2 diabetes and cardio vascular diseases. *Sangrahi* (absorbs excess fluid from intestine and helps for natural compactness of stool & enhance the digestion) property of millets can be indicated in *grahani* (IBS), mal-absorption syndrome and celiac diseases due to absence of gluten in millets. The *brimhana* (nourishing) and *balya* (strengthening) property may be helpful as providing nutrients to the body and overcome the oxidative stress due to rich source of

nutrients and polyphenols. The *lekhana* property clears *srotorodha* (obstruction of channels) and helps to increase the flow of nutrients to the subsequent *dhatu* (tissues) and due to its *bhagna sandhan krita* action (facilitates fracture of healing), it may be helpful in *asthibhagna* (fracture of bone) by supplying calcium, magnesium, phosphorus and other nutrients. *Kaphahara* and *dhatu shoshaka* properties may be helpful to reduce excessive fat in obesity and *pittahara* properties pacify *raktapitta* (bleeding disorders) related disorders.

Analysing the properties and effect of millets (*kshudra dhanya*), it can be suggested that millets may be effective in prevention and management of *santarpanjaniya vyadhi* like *sthoulya* (obesity), *medoroga* (diseases due to excessive lipids), *prameha/ madhumeha* (diabetes mellitus), cardiovascular diseases etc., which are usually metabolic & lifestyle disorders. By this *lekhan* and *medohara* action, the quantity of *meda* (adipose tissue) reduced from the dependable parts of the body, which brought *Laghuta*.

CONCLUSION

Nutritional deficiency leads to several health problems. This is a common problem faced by almost all the developing countries. Hunger is

a challenge for 815 million people all over the world, as reported by World Bank. Millet can serve as a saviour for the world's rapidly increasing population with the potential to prevent food shortages and famine and can ensure nutritional future food security of the country.^[44].

Millets have can be considered as a viable option to live healthy life and the incidence of the lifestyle diseases can be reduced. Hence, the millets may be used as alternative therapy for the management of life style diseases.

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