Review Article

Nutritional benefits of Kodo and Little millet and their role in Dairy industry

ABSTRACT

Aim: The aim of the study is to find out benefits of millets and its role in dairy sector.

Millets are grass crops that have gained importance due to their excellent nutritional profile as well as their adaptability to climate change. Unlike conventional crops like rice and wheat, millets can grow in extreme conditions like drought, hot and arid conditions etc. The major and minor millets both have their benefits. Minor millets include kodo millet, barnyard millet (sawa), little millet (kutki), foxtail millet (Kakum), proso millet (chenna) and two pseudo millets which does not belong to grass family i.e., amaranth (rajkira) and buckwheat (kuttu). These millets have high mineral content compared to other conventional crops. Inclusion of these millets in our daily diet can help in combating malnutrition and deficiency diseases. These crops also have medicinal benefits like lowering the risk of cardiovascular diseases, celiac disease etc. In addition, they are good source of antioxidants like phytates, polyphenols, tannins etc. They are also good source of dietary fiber, have low glycemic index and hence can be a staple food for persons suffering from Diabetes. Millets are an excellent choice for value addition in food processing sector particularly dairy sector. India is the largest producer of millets and they are called as “NUTRI-CEREALS” or “Shree Anna”. It has been a part of diet of tribal people of Jharkhand, Karnataka, Uttarakhand, Orissa and Madhya Pradesh. In this paper, the benefits of kodo and little-millets and their role in the dairy industry have been presented.

Keywords: Nutri-cereal, Kodo millet, Little millet, Bioactive compounds, value addition

1. INTRODUCTION

Since 2018, due to climate change and the lack of nutritional profile of conventional crops, there has been a lot of interest shown by the Government of India in promoting millets. The same year, millets were given the tag of “NUTRI-CEREALS” and 2018 was declared as the National year of millets. India's government had asked the UN to declare 2023 the International Year of Millets (IYOM) for which 72 nations agreed with India's request, and on March 5, 2021, the United Nations General Assembly (UNGA) proclaimed 2023 as the “International Year of Millets”. Millets were also included in the Ministry of Women & Child Development's “POSHAN MISSION” Abhiyan.

India is the largest producer of millet with 17.68% of the share in total production during the year 2020 followed by Nigeria (~11%) and China (~9%). In 2022, India produced 17.60 Million Metric Tonnes (MMT) of millets contributing to 19% of the total millet production in the world. With 17.75 MMT, India was the biggest consumer of millets in 2022, followed by China (13.70 MMT) and Nigeria (8.80 MMT). Also, India is placed 10^{th} in terms of volume with 1.68 lakh MT (0.45% of global commerce), and seventh in terms of value, with exports of millet totaling USD 65.10 Million (1.66% of global trade). Globally, there were 40.44 Million hectares (ha) of sorghum planted in 2022, compared to 31.28 million hectares (ha) of other millets. Sorghum accounted for more than 66% (60.13 MMT) of total millets output, with the remaining 34% coming from other millets (small millets, finger millets, pearl millets, and so on. (YES BANK AND APEDA**,** 2022)

According **to USDA,** small millets account for 11% of the total millet production in India. Madhya Pradesh is the highest producer of small millets (33%) followed by Arunachal Pradesh, Karnataka and Tamil Nadu (9%), Chhattisgarh (7%), Uttarakhand (6%) and Gujarat and Andhra Pradesh (5%). The average production of millets during the last 5 years (2018-19 to 2022-23) is around 12,189 thousand tonnes.

Minor millets include Kodo millet or cow grass (*Paspalum scrobiculatum*) barnyard millet or sawa (*Echinochloa esculenta*), little millet or kutki (*Panicum sumatrense*), foxtail millet or Kakum (*Setariaitalica*), proso millet or chenna (*Panicum miliaceum*) and two pseudo millets which does not belong to grass family include amaranth or rajkira (*Amaranthus caudatus L*.) and buckwheat or kuttu (*Fagopyrum esculentum*).

2. **KODO MILLET**

2.1 Botanical Description

Kodo millet or cow grass belongs to family of *Poaceae*or also known as grass family. It is a long duration crop. The inflorescence of kodo millet consists of 2–6 racemes that are widely dispersed along a short axis or subdigitate. The grain is protected by sticky, persistent, hard husks.Self-pollination is the norm since Kodo millet possesses a cleistogamous flower and because the proportion of open flowers does not surpass 15-20% [1]. While *Paspalum scrobiculatum var. commersonii*is the wild variety native to Africa, ***Paspalum scrobiculatum var. scrobiculatum*** is farmed as an important crop in India. It is a monocot plant with approx. 4 feet in height. The leaves are 20-40 cm long. It produces small, ellipsoidal seeds that are 1.5 mm wide and 2 mm long and range in hue from light brown to dark grey given in Figure 1 [2]. The species *Paspalum scrobiculatum* is split into three races: **Regularis, Irregularis, and Variabilis** based on the morphology of the inflorescence. (ICRISAT, 2017). During 2015-16 the area of production of kodo millet was 1.96 lakh hectare, the production yield was 0.84 lakh tonnes and its total yield was 429 kg/ha. Total 40 improved varieties have been released from 1989 to 2022 (Indian Farming, 2023).Various varieties released by the Indian Institute of Millet Research (IIMR); Hyderabad is given in Figure 2.

Figure 1: Kodo millet seeds

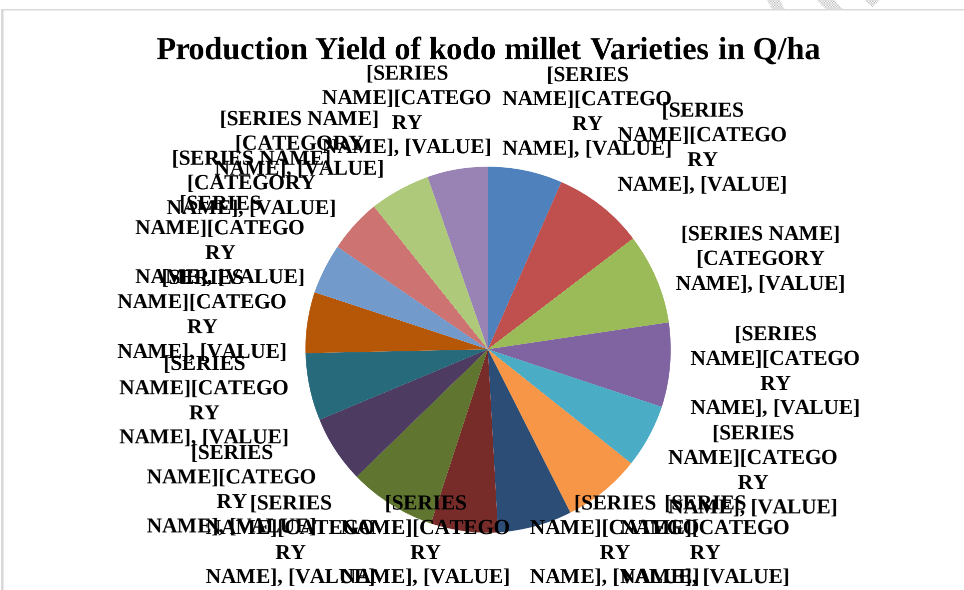


Figure 2

Source: IIMR - *SALIENT FEATURES OF RELEASED VARIETIES OF KODO MILLET CROPS* (1989 TO 2012)

2.2 Nutritional Composition of Kodo millet

According to Muragod*et al.,* 2019**,** the physico-chemical composition of kodo millet includes its size (1.7 mm), thousand grain weight (2.8 gm), thousand grain volume (1.2 ml), bulk density (1.84), hydration capacity in gm per 1000 seeds is 0.54 while its hydration index is 24.52%. The swelling capacity in gm per 1000 seeds and swelling index is 0.55 and 42.30%, respectively. The proximate composition per 100 gm of kodo millet includes its moisture (11.2%), fat (1.3 g), protein (8.1 g), carbohydrate (64.3 g) and fiber (8.3 mg). The kodo millet also has significant quantities of minerals like Iron (0.5 mg), phosphorus (169 mg) and calcium (32 mg) [**3**]**.**Another author also reported similar findings which said that kodo grains have 8.35% protein, 1.45% fat, 65.65% carbohydrate, and 2.95% ash. The study also revealed that kodo millets are high in vitamin B_3, vitamin B_6, folic acid, and minerals including calcium, potassium, magnesium, and zinc, as well as having medical advantages for diabetes, celiac disease, cancer, cardiovascular disease, and so on [**4]**The vitamin and mineral profile is given in Table 1. The energy value of kodo millet is between 340-342 kcal/100 gm**[5**].Kodo millet has more ash and dietary fiber content as compared to wheat and rice**[6,7]**(Table 2)

Table 1: Vitamin and mineral profile of millets compared to cereals

S.no	Name of cereal/ and millets	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin B_3 (mg)	Total folates (µg)	Iron (mg)	Phosphorus (mg)	Calcium (mg)	Sodium (mg)	Magnesium (mg)
1.	Whole wheat	0.46	0.15	2.68	30.09	3.97	315	30.94	2.04	125
2.	Rice	0.05	0.05	1.69	9.32	0.002	96	7.49	2.34	19.3
3.	Little millet	0.26	0.05	1.29	36.20	1.26	130	16.06	4.77	91.41
4.	Kodo millet	0.29	0.2	1.49	39.49	2.34	101	15.27	3.35	122

Source: Dayakar Rao et al., 2017 (Indian Institute of Millet Research); Dey et al., 2022

Table 2: Nutritional comparison of millets with wheat and rice per 100 gm

S.no	**Name of cereal and millets**	**Moisture (g)**	**Fat (g)**	**Ash (g)**	**Protein (g)**	**Carbohydrate (g)**	**Total dietary fiber (g)**	**Energy (Kcal)**
1.	Whole wheat	10.58	1.47	1.42	10.6	64.70	11.23	1347
2.	Rice	9.93	0.52	0.56	7.94	78.24	2.81	1491
3.	Little millet	14.23	2.55	1.72	8.92	65.55	6.3	1449
4.	Kodo millet	11.6	4.2	2.95	10.6	59.2	10.2	346

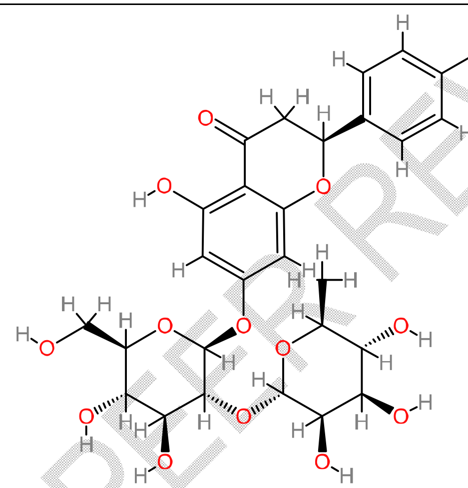
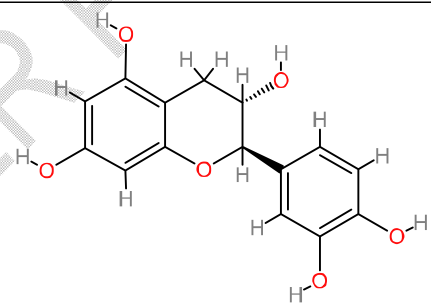
Source: Dayakar Rao et al., 2017 (Indian Institute of Millet Research), Indian superfood millet APEDA report; Bunkar et al., 2021

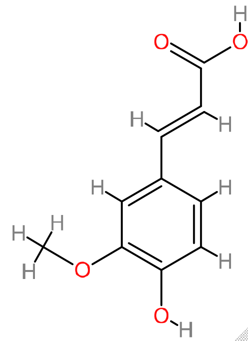
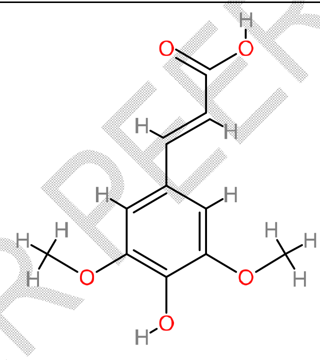
2.3Bioactive compounds in Kodo millet

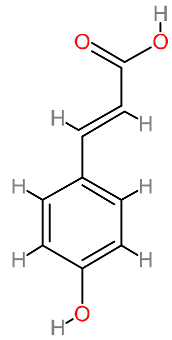
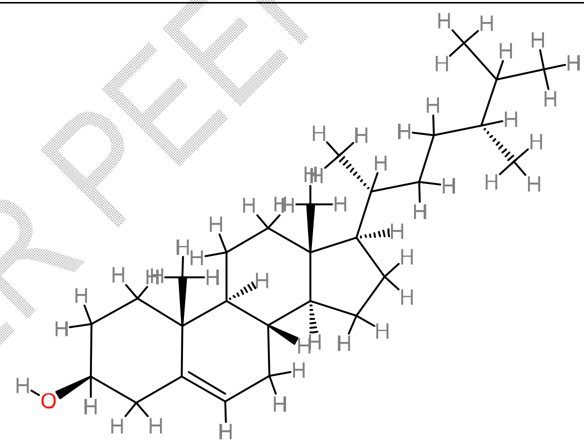
Malnutrition is common nowadays because individuals are not obtaining adequate nutrition from traditional crops, and dining out is popular in cities, which boosts junk food intake among children. This culture is the root cause of many ailments in today's society including cancer. It may be avoided in the future by replacing wheat and rice with millets, which are high in bioactive chemicals.

Kodo is an ancient millet grain that originated in tropical Africa and was domesticated 3000 years ago in India.This Indian cow grass is also referred to as Kodra and Varagu. The three categories of bioactive chemicals include alkaloids, terpenes and terpenoids, and phenolic compounds which includes phytochemicals such as Naringin, catechin, luteolin, apigenin, daidzein, naringenin etc. These compounds have various health benefits **[8**]. They are also called secondary metabolites. Secondary metabolites in plants are divided into three categories based on their metabolic pathway: (a) nitrogen-containing chemicals like alkaloids, glucosinolates, and cyanogenic glycosides, (b) phenolic compounds like phenylpropanoids and flavonoids, and (c) terpenes. Alkaloids are a type of nitrogen-containing chemicals generated in plants in response to biotic or abiotic stimuli, endowing alkaloids with extraordinary biological activity while shikimate, pentose phosphate, and phenylpropanoid pathways in plants are the sources of phenolic components, which include an aromatic ring with one or more hydroxyl groups. Also, terpenoids are the most prevalent category of secondary metabolites generated by plants and are found in flowers, vegetative tissues, and roots. They exhibit a wide spectrum of biological actions that lead to reduced total cholesterol, triglycerides, or LDL cholesterol, as well as blood pressure **[9].** Some bioactive compounds reported by **Khare *et al.,* 2020** in Kodo millets are Naringin (11.9 ppm), Catechin (1.10 ppm), Ferulic acid (2.45 ppm), Sinapic Acid (7.9 ppm) and *P*-Coumaric acid (1.38 ppm)**[10].**Another author reported that the concentration of campesterol in raw kodo millet was 0.31 % while after germination the concentration increased to 2.6 % [**11**]. The protective functions of different bioactive compounds are given in Table 3

Table 3: Bioactive compounds found in Kodo millet and their protective functions.

S.no	Name of bioactive compound	Molecular Formula	PubChem CID	Molecular Structure	Nature of Protective functions	Reference
1.	Naringin	$C_{27}H_{32}O_{14}$	442428		Anti-oxidant and anti-inflammatory, treatment of Parkinson's disease, Alzheimer's disease lowers cholesterol and reduces the risk of CVDs	[**10,12,13**]
2.	Catechin	$C_{15}H_{14}O_6$	9064		Anti-inflammatory, Anti-cancer, Anti-oxidative properties	[**10,14**]

S.no	Name of bioactive compound	Molecular Formula	PubChem CID	Molecular Structure	Nature of Protective functions	Reference
3.	Ferulic acid	$C_{10}H_{10}O_4$	445858		Anti-oxidant, anti-microbial, anti-viral, anti-cancerous, vasodilator activity and anti-diabetic activity	[10,15]
4.	Sinapic Acid	$C_{11}H_{12}O_5$	637775		Anti-viral property against SARS Cov, Anti-inflammatory, Anti- cancer	[10,16,17]

S.no	Name of bioactive compound	Molecular Formula	PubChem CID	Molecular Structure	Nature of Protective functions	Reference
5.	*P*-Coumaric acid	$C_9H_8O_3$	637542		Anti- inflammatory, Anti- cancer, Anti-oxidant, treatment of Rheumatoid arthritis; Anti-obesity	[10,18,19,20]
6.	Campesterol	$C_{28}H_{48}O$	173183		Lowers cholesterol, Anti-cancerous	[21]

Source of images: PubChem

3. LITTLE MILLET

3.1 Botanical Description

Little millet (*Panicum sumatrense*) also known as Samai or kutki is a minor millet which is of *Poaceae* family. It is native of Indian subcontinent. It is self-pollinated with chromosome number 36. The inflorescence of the little millet is a panicle that is 15-45 cm long and 1-5 cm broad. The spikelet is 2.0-3.5 mm in length. At maturity, panicle branches are scabrous and drooping. The lower is sterile, whereas the top is fertile or bisexual with no rachilla extension. Spikelets are elliptical, acute and compressed dorsally **[22]**.*P. sumatrense* is divided into two subspecies based on inflorescence morphology: *psilopodium*and *sumatrense*. The race ***Nana* and *Robusta*** are subspecies of Sumatrense. The race Nana has two subraces: ***Laxa* and *Erecta****,* and the race Robusta has two subraces: ***Laxa* and *Compacta***(ICRISAT 2017**).** The grain is 1.8-1.9 mm in length and is smooth on the surface. The major states involved in its cultivation are Orissa, Madhya Pradesh, Andhra Pradesh, Karnataka, Maharashtra and Gujarat. It is resistant to both waterlogging and drought [**23]**. During 2015-16 the area of production of little millet was 2.34 lakh hectare, the production yield was 1.27 lakh tonnes and its total yield was 544 kg/ha. Total 32 improved varieties have been released from 1989 to 2022 (Indian Farming, 2023)**.** Various varieties released by IIMR of little millet with their average yield is given in Figure 3.

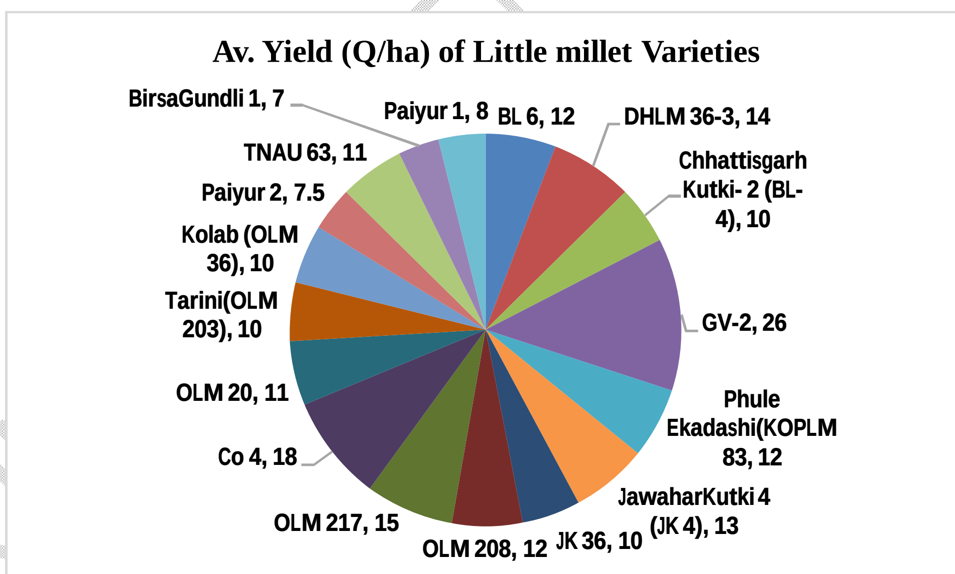


Figure 3

Source: IIMR [*SALIENT FEATURES OF RELEASED VARIETIES OF LITTLE MILLET CROPS* (1989 TO 2016)]

3.2 Nutritional composition

Kamatar*et al*., 2013 investigated little millet specimens from Karnataka's study districts for physical properties and classified based on seed color. They were divided into four groups: light brown, reddish brown, creamish brown, and blackish brown.The grain's thousand grain weight ranged from 2.40 to 2.80 g, while its bulk density ranged from 0.81 to 1.40 g/ml. The grains' mean hydration capacity varied between 9.13 to 21.50 % whereas their swelling capacity ranged from 11 to 51 %. The grain required 10-15 minutes for cooking. After cooking, the Hydration capacity (160-260 %) and swelling capacity (220-280%) increased significantly [**24**]. Another author studied the physical characteristics of S*ukshema*, an enhanced cultivar of a local genotype of little millet. The results revealed that the grain's length, width, and thickness were 1.74 mm, 1.53 mm, and 1.09 mm, respectively. The solubility was 23.4 % and water absorption capacity was 0.88 g/g. The total dietary fiber was 8.81 g/100g. Total sugar was around 4.14 g/100g. Table 2 describes the proximate composition of little millet [**25].**

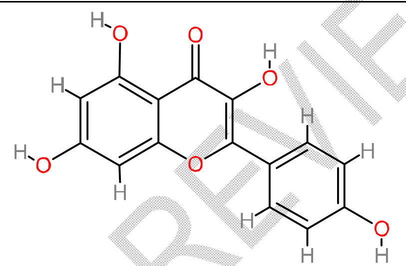
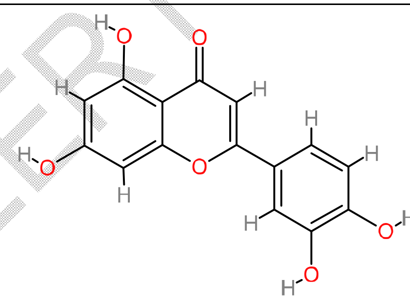
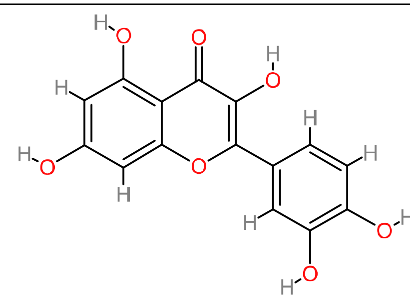
3.3 Bioactive components

Little millet also has various bioactive components which may have ability to protect against several diseases. One articlereported that the Total phenolic content (TPC) content of little millet was around 521 mgGAE/100 g with compounds like Gallic acid, Proto-catechuic acid, Kaempferol, ferulic acid, p-hydroxy-benzoic acid, Gentisic acid, vanillic acid, syringic acid and trans-cinnamic acid**[26].** Similarly, **another** also suggested that little millet can be used as functional food component to control postprandial hyperglycemia. The TPC content of 3 cultivars of little millet was reported between 23-24 µmol ferulic acid equivalents/g and Total soluble Flavonoid content was between 11.33-13.64 µmol catechin equivalents/g. Among the 3 cultivars, compounds identified were Catechin, luteolin, naringenin, quercetin, apigenin, quercetin, and kaempferol. According to the results shown by the study, kaempferol and luteolin were the most abundant flavonoids. The luteolin content was highest in CO4 cultivar (69.24±2.13 µg/g) while kaempferol (60.57±2.15 µg/g) was highest in CO2 cultivar of little millet. The DPPH scavenging activity was also highest in CO2**[27].**

Luteolin is a flavonoidthat occurs naturally as a glycosylated form in a variety of fruits and vegetables. It has antioxidant, anticancer, anti-inflammatory, and neuroprotective properties. Kaempferol is also a flavanol that belongs to the flavonoid family and is found in a variety of plant genera including Delphinium, Berberis, Camellia, Citrus, and others. Kaempferol is useful in a variety of inflammatory disorders, including cardiovascular, cancer, and neurological diseases. Kaempferol's anti-inflammatory properties are attributable to its reduction of inflammatory cell activity as well as its inhibition of proinflammatory cytokines and chemokine expression [**28]**.

The molecular structure and protective functions of bio-actives molecules found in little millet are presented in Table 4.

Table 4: Important bioactive components in little millet

S.no	Name of Compound	Molecular formula	PubChem CID	Molecular structure	Protective functions	Reference
1.	Kaempferol	$C_{15}H_{10}O_6$	5280863		Anti-inflammatory	**[29]**
2.	Luteolin	$C_{15}H_{10}O_6$	5280445		Anti-inflammatory, Anti-cancer	**[30]**
3.	Quercetin	$C_{15}H_{10}O_7$	5280343		Anti-inflammatory, Anti-obesity	**[31]**

4. CHANGES IN THE NUTRITIONAL COMPOSITION OF MILLETS UNDER DIFFERENT PROCESSING CONDITIONS.

Dehusking, soaking, milling, germination, fermentation, malting, heating, and roasting are all part of the processing process. All these practices have significant impact on the nutritional and nutraceutical properties of millets.

Germination is a natural process used to activate grains biologically in order to increase their nutritional and functional qualities. Soaking, sprouting, and drying are part of Malting process. Roasting, parboiling and puffing are examples of heat treatments. These treatments improve millet's eating quality, although their impact on nutritional qualities such as TPC vary according to the heating method **[32].**Sprouting of millets can increase its nutritional profile such as essential amino acids, anti-oxidants, minerals etc. During germination, kernels are often soaked in water before being let to germinate in a controlled atmosphere. As a result, sprouting circumstances and water content have a significant influence on its metabolic process. Soaking the kernel at ambient temperature for a few to 24 hours, with a seed weight/volume ratio of 1:1.5 to 1:20, is a common practice performed prior to seed germination. The ideal temperature for germination is 20-30°C [**33]**. Soaking also reduces anti-nutritional factors like phytates in cereal crops. A comparative study of 5 different millets revealed that 24h soaking and 24h germination was superior for creating nutritionally enhanced millet products. 50% tannin content was reduced in little millet while in kodo millet it was reduced from 1.42 mg/g to 0.52 mg/g after treatment. Also, DPPH activity rose from 34.12% to 56.16% in little millet and from 56.71% to 78.34% in kodo millet after 24 hours of soaking and germination **[34]**

Guha *et al.,* 2015 also reported that processing conditions like germinating, steaming and roasting of little millet also influence the concentration of bioactive components. The comparison between native and processed millets shows that TPC content was highest in Roasted little millet. The decreasing order of TPC value was Roasted (521.0 mg GAE/100 g) > Steamed (485 mg GAE/100g) > germinated (453 mg GAE/100g) > Unprocessed (429 mg GAE/100g). The trend was similar in the case of Total Flavonoid content [**35]**

Similar results were reported by another authorwhere TPC content increased from 27 to 34 mg TAE/100g after 12 h of soaking and 48 h of germination and popping of kodo millet increased TPC content to 63.58 mg TAE/100g**[36**].

Other studies also indicate that Protein content increased significantly from 6.7% to 7.9%, minerals increased from 232.82 to 251.73mg/100g, dietary fibers increased from 35.30 to 38.34g/100g, and GABA content increased from 9.36 to 47.43mg/100g, while tannins and phytates reduced from 1.603 to 0.234mg/100g and 1.344 to 0.997mol/kg, respectively, in sprouted Kodo millet sample. It was also seen that lipid content decreased from 3.6 to 2.8%. Similarly to prior investigations, the DPPH radical scavenging activity (%) was raised (67.35 to 91.34%) [**37].**

Roasting also influences the Bioavailability of nutrients. Singh *et al*., 2018 reported that roasted samples of finger millet showed a reduction in phytochemical elements such as phenols and antioxidant activity. It may be due to exposure to heating. The fat and protein content also decreased while total carbohydrate increased after roasting. The iron content increased from 3.45 to 3.91 mg/100g and calcium was increased from 337-341 mg/100g [**38]**.

Fermentation is an ancient technique which is quite popular for increasing probiotic content in food along which influencing the nutrients present in food. One of the literatures reported that little millet fermented with *Saccharomyces boulardii* and *Lactobacillus acidophilus* compared to germinated onehas significant impact on its nutrients. The results revealed that Protein content increased from 9.86 to 10.95 %, fat content decreased from 3.26 to 2.61 %, Ash content increased from 2.27 to 2.34 and carbohydrates reduced from 84.54 to 82.01 %. The phytic acid content was reduced as well upon fermentation. So, it can be inferred that germination and fermentation when combined will improve the nutritional quality of the food [**39]**.

Similar study was reported on kodo millet malt beverage inoculated with 4 different strains namely *Pediococcusacidilactici*, *Lactobacillus plantarum,Lactobacillus fermentum.*The results were similar to fermented little millet. The protein, antioxidants and crude fat increased**[40].**

5. MILLETS IN DAIRY INDUSTRY

Value added products of millets has been gaining popularity since the last 5-6 years. In the past decade, weaning mixes, health drinks, imitation dairy products using millets were developed by the researchers. Millet's starch functionality is equivalent to that of other cereals. Millets are appropriate constituents in various food compositions for certain target groups due to their increased proportion of non-starchy polysaccharides, dietary fiber, and low glycemic index. Millet's alkaline composition also makes them beneficial for people suffering from acidosis and gastric ulcers. **[41]**. Some product categories are described below:

a) Health Drinks

Health drinks are bgaining popularity among consumers due to its high nutrient profile. Several studies of milk and millet based health drinks indicate the interest among researchers. Kumar *et al.,* (2013) developed health drink powder by combining malted finger millet (*Eleusine coracana*), different pulse combinations, and skim milk powder. When compared to other health beverages available in the market, it has a fairly high protein (25.01%) and calcium (Ca-1018.7 mg/100 g) content. Sensory analysis revealed that it has a better acceptance among consumers and is also a cost-effective product**[42**].Parvathi *et al*., (2015)also developed a millet-based dairy health drink targeting malnutrition in children. The product was developed by utilizing pearl, kodo, and whole wheat that had been germinated, as well as pulses. The dried germinated millets were roasted until the husks split apart, and they were then ground into a fine flour in a burr mill. Green gram flour, roasted bengal gram flour, and skim milk powder were then added to the flour. The health mix's DPPH scavenging activity was found to be 0.664 0.08 mg/g. In every 100 gm of the standardized mix, there were 17.08% protein, 4.05% fibre, 20.68 mg of calcium, and 7.57 mg of iron**[43].** Another study was done on health drink targeting diabetic people using millets like bajra and ragi. Organoleptic and nutritional composition as well as phytochemical analysis showed that multigrain health mix was a superior product and can be used for diabetic people [**44]**. Similarly, milk-based iron rich health drink was developed to combat malnutrition using sprouted and dried pearl milletflour, finger millet powder, malted soya flour, sugar powder, milk powder and popped and milled amaranth seed powderin different combinations. The effect of sprouting on the nutritional content of a bajra-based health drink indicated that sprouting reduced the carbohydrate (67.46g), fat (5.30g), moisture, and fibre contents (1.12g) compared to the control (100% pearl millet flour). The fat content reduced due to action of lipolytic enzyme and protein content increased from 11.2 g to 13.54g**[45].**Another author developed a millet-based health drink using germinated kodo millet, barnyard millet, small millet, and finger millet and compared it with other health drinks available on the market. The results revealed that apart from energy, a health drink made from minor millets contains vital nutrients and is economically feasible for the consumers**[46].**

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b) Porridge/Kheer mix

A ready to constitute kheer mix powder using pearl millet, dairy whitener, sugar and cardamom was developed. The millet was autoclaved for 15 minutes at 121°C and incubated at 35°C for 30 minutes before making the kheer mix. RSM (Response surface methodology) was used to optimize the final product which showed that increase in dairy whitener had positive effect on OA (Overall Acceptability) score**[47].** Similar study was conducted where nutrient-enriched millet-based composite flour using skimmed milk powder and vegetables was developed for children aged 6 to 59 months. Finger Millets were germinated and roasted and combined with pumpkin seeds, carrots, cowpea leaves, and skimmed milk powder to make a composite flour. The findings indicate that increasing the germination time improved the protein, protein digestibility, and total sugar content of millet flour by 0.03%, 0.79%, and 0.07%, respectively, while decreasing total phytates by 0.005 mg/g**[48].**AlsoBunkar *et al.,*(2020)developedinstant Kodo Millet Based Porridge Mix using Kodo millet, skim milk powder with stevia @ 8%. The optimized product had 72.6± 4.34 g/100gm of anti-oxidant content and 72.6± 4.34 g/100gm of ash content**[49].**

c) Weaning mix

Weaning is a phase of transition in which the infant's nutrition changes in terms of source and consistency. Weaning is a phase when children are nutritionally vulnerable. To benefit from increased micronutrients, cereals in composite mixes might be substituted with millets in the formulation with milk. Both milk and millets can provide a balanced nutrition to children. Several studies were conducted one of which wason weaning food based on using Barnyard millet, foxtail millet, soyabean and skim milk powder**.** Milletswere malted while soyabean was roasted to create the mix. The product was rich in protein (18.37 %) and Ash content (4%). The calcium and ascorbic acid content was also high. The sensory analysis indicated that product was highly accepted by the consumer with OA (Overall acceptability) score 7.7**[50]**. Similarly Balasubramanian *et al*., (2011) also developed a weaning mix using pearl millet, barley, whey protein concentrate vegetable oil and skim milk powder**.** He usedextrusion to create extrudates of raw and malted pearl millet and barley. The overall acceptability of optimized product was between 6.60 to 8.20 [**51**]. Another study was done on weaning mix for children using little, kodo, foxtail and finger millet in different proportions. All millets were germinated before using. In comparison to the wheat-based market sample, millet-based weaning mixtures were higher in protein (14.3 to 23.17%), ash (2.8 to 7.6%), and crude fiber (2.5 to 6.0%). The calcium content of formulated millet-based goods is similar to that of the market sample without fortification**[52].**

d) Fermented Milk-Millet Foods

Fermented foods are source of probiotics which is becoming popular in developing countries. Fermentation of grains is an old and low-cost technique of food preservation. One of the product developed was a fermented skim milk and pearl millet product. Skim milk and ungerminated pearl millet flour were used as raw materials, and curry patta*(Murrayakoenigii),* black pepper (*Piper nigrum*), cumin (*Cuminum cyminum*), and salt were used as flavouring agents. The milk was inoculated with 2% *S. thermophilus* and *L. rhamnosus*RSI3. The study revealed that the product has 5.01% protein, 0.82 % ash, 8.95 cfu/g LAB count, 0.73% fat and 82.18 % moisture. The product was similar to Rabadi in consistency**[53].**

Another author also developed a milk and millet based fermented drink using *S. thermophilus* C106 and *L. rhamnosus* GR-1. 1 litre of 3.25 % homogenized milk was mixed with hulled millet and heated at 85-90°C for 3.-60 minutes. Then the culture was added after cooling it at 40°C. Sensory tests revealed that millet fermented in milk was the most appealing. Viable counts of probiotic bacteria was more than 106 colony-forming units (CFU)/ml**[54].**Also, Millet milk curd was developedby germinating foxtail millet, little millet, kodo millet, proso millet, and barnyard millet. Germinated millets are used to extract milk and inoculated with NCDC 26. The curd like mass obtained was analysed and it was observed that acidity ranged from 0.74 to 1.2%, while the pH ranged from 3.5 to 4.5 [**55]**. Similarly a probiotic rich millet milk was developed using *Lactobacillus kefir.* Kefir millet fermented milk had much more protein, polyphenol, viable count, and acidity than the other commercially available comparable drinks [**56**].

6. CONCLUSION

Minor millets are not only cost effective but is excellent tool for value addition due to their nutraceutical properties. Minor millets are a field which is already getting attention due to their potential in decreasing, malnutritional as well as their bioactive profile. Kodo and little millet are one of the oldest grains and have been source of micro-nutrients in various traditional recipes. Also, with shortage of conventional cereal crops all around the world, millets can be an excellent replacement. Not only they are drought resistant, they have the ability to resist other climatic stress conditions. So, it is important to encourage millet production. Commercialization of millet-based product can attract consumers to make millet as part of their staple diet. Today's consumer is health conscious and demands health and tasty food. So, there is a great opportunity to undertake extensive research for developing higher quality millet goods that are healthy, delicious, have a long shelf life, are appealing in colour and appearance, as well as accessible to customers of all economic levels. Dairy products have wider acceptability among consumers, so it is an excellent tool of value addition. Millets can compensate for nutrients like iron which is deficient in milk.

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