

NUTRITIONAL COMPOSITION AND HEALTH BENEFITS OF MILLETS

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Millets

Millet crops are minor cereals of grass family Poaceae, comprises of sorghum, pearl, finger, kodo, foxtail, proso, little, barnyard

Small Millets: Finger, kodo, foxtail, proso, little, barnyard

Major millets

- ❖ Pearl millet (*Pennisetum glaucum*, Bajra)
- ❖ Finger millet (*Eleusine coracana*, Mandua, Ragi)

Minor millets

- ❖ Foxtail millet (*Setaria italica*, Kakum/ Kangni)
- ❖ Proso millet (*Panicum miliaceum*, Barre)
- ❖ Little millet (*Panicum sumatrense*, Kutki)
- ❖ Kodo millet (*Paspalum scrobiculatum*, Kodon)
- ❖ Barnyard millet (*Echinochloa frumentacea*, Sanwa)

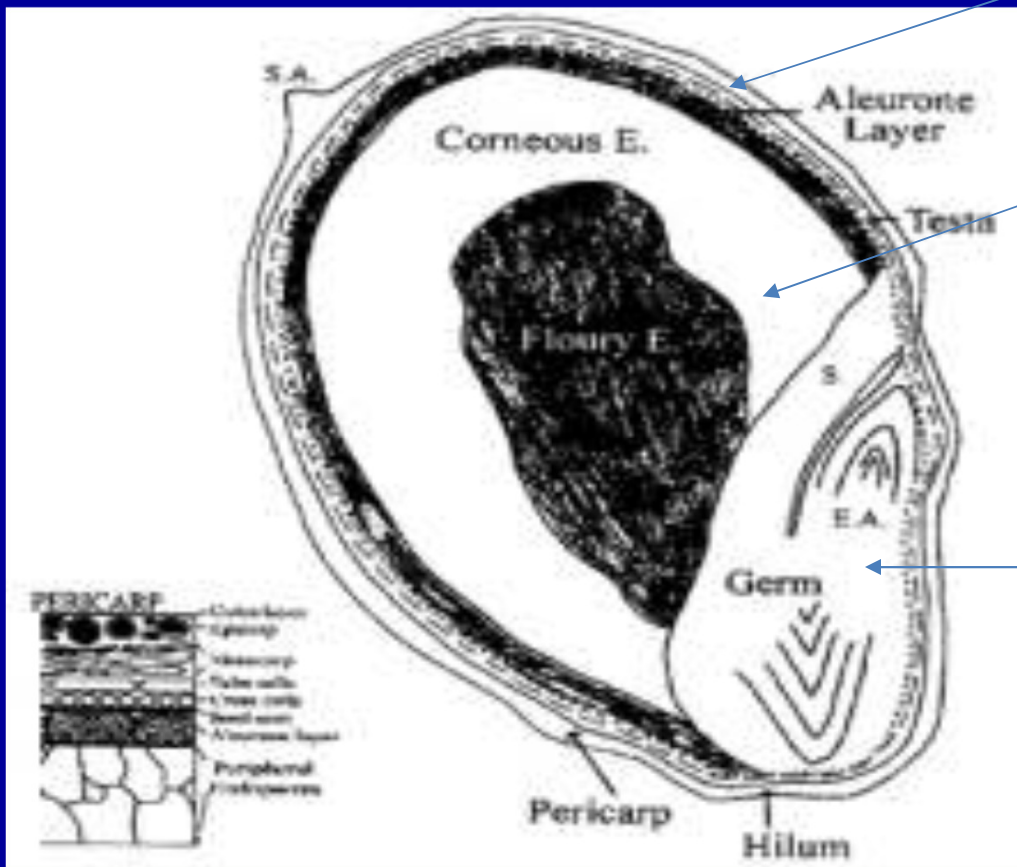


Distribution of nutrients and phytochemicals in millets

Peripheral layers rich in dietary fibre, minerals, phytochemicals (phenolic compounds)

Endosperm has starch, protein with minor levels of fat and fibre

Rich in protein, fat and minerals



General structure of millets

Source: Nutrition and health benefits of millets – IIMR, ICAR, ISBN: 81-89335-55-3



Cereals Vs Millets

Nutrient composition of millet and cereals (per 100 g of edible portion)

Parameter	Protein (g)	Fat (g)	Minerals (g)	Total Dietary fiber (g)	Insoluble Dietary fiber (g)	Soluble Dietary fiber (g)	CHO (g)
Rice milled	7.94	0.52	0.6	2.81	1.99	0.82	78.2
Whole Wheat	10.6	1.5	1.4	11.2	9.6	1.6	64.0
Finger	7.2	1.9	2.0	11.2	9.5	1.7	66.8
*Proso	12.5	1.1	1.9	-	-	-	70.4
*Foxtail	12.3	4.3	3.3				60.9
*Little	10.4	3.9	1.3	7.7	5.5	2.3	65.6
*Kodo	8.9	2.6	1.7	6.4	4.3	2.1	66.2
*Barnyard	6.2	4.4	2.2		-	-	65.5
pearl	11.0	5.4	1.4	11.5	9.1	2.3	61.8
*Sorghum	10.0	1.7	1.4	10.2	8.5	1.7	67.7

*No clue whether polished/unpolished

Source: IFCT 2017, Nutritive value of Indian Foods, 2009



Vitamins & minerals composition of millets (mg per 100 g of edible portion)

Parameter	Finger	Proso	Foxtail	Little	Kodo	Barnyard	Pearl	Sorghum	Rice raw milled	Wheat
Vitamins										
Total Carotenoids	154	-	32	120	272	-	293	212	16.9	287
Thiamine	0.37	0.20	0.59	0.26	0.29	(0.33)	0.33	0.35	0.05	0.45
Riboflavin	0.17	0.18	0.11	0.05	0.20	(0.10)	0.25	0.14	0.05	0.17
Niacin	1.34	2.3	3.2	1.29	1.49	4.2	2.3	2.1	1.69	5.5
Minerals and trace elements										
Calcium	364	14	31	16.06	15.27	20	42	27.6	7.49	41
Phosphorus	283	206	290	220	188	280	296	274	160	306
Iron	4.62	0.8	2.8	1.26	2.34	5.0	8.0	3.95	0.65	5.3
Magnesium	137	153	81	133	147	82	137	1.33	64	138
Sodium	11	8.2	4.6	8.1	4.6	–	10.9	5.42	–	17.1
Potassium	408	113	250	129	144	–	307	328	–	284
Copper	0.67	1.60	1.40	0.34	0.26	0.60	1.06	0.45	0.23	0.68
Zinc	2.3	1.4	2.4	3.7	0.7	3.0	3.1	1.96	1.3	2.7

Source: IFCT 2017, Nutritive value of Indian Foods, 2009

Essential amino acids (mg/g N)

Parameters	Finger	Proso	Foxtail	Little	Kodo	Barnyard	Pearl	Sorghum	Rice (raw) milled	Wheat
Arginine	300	290	220	250	270	-	300	240	480	290
Histidine	130	110	130	120	120	-	140	160	130	130
Lysine	220	190	140	110	150	-	190	150	230	170
Tryptophan	100	050	060	060	50	-	110	70	080	070
Phenylalanine	310	310	420	330	430	-	290	300	280	280
Tyrosine	220	—	—	-	-	-	200	180	290	180
Methionine	210	160	180	180	180	-	150	100	150	090
Cystine	140	—	100	090	110	-	110	090	90	140
Threonine	240	150	190	190	200	-	240	210	230	180
Leucine	690	760	1040	760	650	-	750	880	500	410
Isoleucine	400	410	480	370	360	-	260	270	300	220
Valine	480	410	430	350	410	-	330	340	380	280

Source: Gopalan et al. (2009).

Phytochemicals in millets

- More than 50 phenolic compounds belonging to several classes, phenolic acids and their derivatives, dehydrodiferulates and dehydro-triferulates, flavan-3-ol monomers and dimers, flavonols, flavones and flavanonols identified in whole kodo, finger, foxtail, proso, little and pearl millets
- Pigmented sorghum and finger millet contains anthocyanins and condensed tannins
- Finger millet seed coat is a rich source of phenolic compounds
- Research is needed on millet phenolics to examine their bio-availability, metabolism and health contribution to humans

Source: Chandrasekara & Shahidi (2011); Shahidi & Chandrasekara (2013); Dykes & Rooney (2007)



Some of the health beneficial properties of millets reported in literature

- Antioxidant
 - Antimicrobial
 - Inhibition of protein glycation
 - Enzyme inhibitory properties
 - Wound healing
 - Blood glucose lowering
 - Cholesterol lowering
 - Delay of onset of cataractogenesis
 - Anti-ulcerative
 - Anti-cancer
 - Natural probiotic treatment for diarrhea
 - Improvement of hemoglobin status in children
 - Improvement in insulin sensitivity
 - Improve HDL levels, adiponectin levels and decrease blood glucose, triglycerides
- ❖ **Very few human trials to substantiate the health benefits on millets**

In vitro and
animal studies

Available carbohydrate contents of Cereals Vs Millets

Grain	Available carbohydrate (g)	Amylose	Amylopectin
Rice milled	76.4	12-19 (short grain)	81-88 (short grain)
Wheat	59.3	25	75
Finger	62.5	16	84
proso	-	28.2	71.8
Foxtail	-	17.5	82.5
Little	66.4	-	-
Kodo	66.2	24	76
Barnyard	-	-	-
pearl	56.0	21.1	78.9
Sorghum	61.0	24	76

- Available carbohydrate contents in millets are lower
- Proso, kodo and sorghum contains appreciable levels of amylose

Source: IFCT 2017, Nutrition and health benefits of millets – IIMR, ICAR, ISBN: 81-89335-55-3



Glycemic index of millet foods reported in literature

Millet foods	GI	Millet foods	GI
Multigrain sorghum <i>roti</i>	68	Dehulled barnyard milled cooked	50
Sorghum Coarse semolina <i>upma</i>	53	Heat treated and dehulled barnyard millet	41.7
Sorghum fine semolina <i>upma</i>	56	Barnyard and kodo millet based noodles	84.8
Sorghum flakes <i>poha</i>	45	Foxtail millet biscuit	50.8
Sorghum pasta	46	Barnyard millet biscuit	68
Sorghum biscuits	54	Finger millet roasted bread	104
Foxtail, barnyard millet millet dokhla (with legumes & fenugreek)	35	Pressure cooked kodo millet	68
Foxtail, barnyard millet <i>upma</i> (with legumes & fenugreek)	17.6	Bajra roasted bread	55
Foxtail millet <i>laddu</i> (with amaranth, roasted legumes)	23.5	Jowar roasted bread	77
Boiled millet (Canada)	71	Millet flour porridge (kenya)	107
Finger millet dumplings	69	Decorticated finger millet cooked	81

Source: International tables of GI, Shobana et al (2013), shobana (2009), Nutrition and health benefits of millets – IIMR, ICAR, ISBN: 81-89335-55-3

STUDIES ON MILLETS AT MDRF

NUTRIENT COMPOSITION OF FINGER MILLET BASED PRODUCTS

Name of the sample	Protein % (N*6.25)	Fat %	Ash %	Available CHO %	TDF %
Ragi	7.04	1.32	2.61	61.73	12.69
Partially decorticated Ragi (PDR)	6.66	0.90	1.41	74.39	5.82
Polished white rice* (PWR)	6.3	0.7	0.5	80.1	1
Ragi Flakes (RF)	7.42	1.21	1.91	62.68	12.30
White Rice Flakes (WRF)	9.87	0.84	1.02	73.56	1.08
Ragi Vermicelli (RV)	13.43	0.60	2.86	57.65	13.56
Maida Vermicelli (MV)	10.03	0.54	0.78	73.19	3.95
RTE Ragi snack (RS)	11.39	0.17	3.84	63.87	16.45
Commercial RTE snack (CS)	6.18	34.77	2.91	50.65	2.80
Partially Decorticated Ragi Upma (PDRU)	3.90	2.27	2.50	28.65	6.69
Ragi Flakes Upma (RFU)	4.22	2.00	2.11	22.96	7.89
Ragi Vermicelli Upma (RVU)	5.93	2.14	2.79	20.38	8.66

Source: Shobana et al (2017) . APJCN (Accepted manuscript) Study sponsored by ICMR



GLYCEMIC INDEX (GI) OF FINGER MILLET PRODUCTS

Product	N	GI		GI classification
		Mean	SEM	
Decorticated millet Upma	16	84.7	7.7	High
Flakes Upma	16	82.3	6.4	High
Vermicelli Upma	16	65.5	5.1	Medium
Extruded snack	12	65.0	6.6	Medium

Source: Shobana et al (2017). APJCN (Accepted manuscript)

Study sponsored by ICMR



Ready-to-cook foods based on millets



Millet upma



Millet sambar mix



- Based on unpolished millets (little and foxtail)
- Healthier meal replacer for regular sambar rice/upma made out of fibre depleted polished rice/ wheat semolina.

Source: Shobana et al (ICAR Project)

Conclusions

- Unpolished millets - nutritionally superior
- Nutrient data base for millets –whole and polished
- Availability of unpolished millets - lower in Chennai market- awareness to be created on features of unpolished millets
- Finger millets diets elicits similar glycemic response as that of white rice
- Randomized control trials in humans are needed to confirm *in vitro* & animal studies findings on millets
- GI of millet foods range from low to high, difficult to draw conclusions due to gaps in the GI methodology

Thank you

