

Research on product development and health benefits of small millet foods by TNAU

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PRODUCT DEVELOPMENT

NUTRIENT CONTENT OF SMALL MILLETS

S.No	Small millets	Protein (g)	Fat (g)	Carbohydrate (g)	Energy (K.Cal.)	Calcium (mg)	Phosphorous (mg)	Iron (mg)	Iodine (mg)	Thiamine (mg)	Riboflavin (mg)	Fibre (g)
1	Rice	6.40	0.40	79.00	346.00	9.00	143.00	1.00	-	0.21	0.05	0.20
2.	Wheat	11.80	1.50	71.20	346.00	41.00	306.00	5.30	64.00	0.45	0.17	1.20
3.	Finger millet	7.30	1.30	72.00	328.00	344.00	283.00	3.90	42.00	0.42	0.19	3.60
4.	Little millet	7.70	4.70	67.00	341.00	17.00	220.00	9.30	0	0.30	0.09	7.60
5.	Kodo millet	8.30	1.40	65.90	309.00	27.00	188.00	0.50	0	0.33	0.09	9.00
6.	Foxtail Millet	12.30	4.30	60.90	331.00	31.00	290.00	2.80	32.00	0.59	0.11	8.00
7.	Proso millet	12.50	1.10	70.40	341.00	14.00	206.00	0.80	0	0.20	0.18	2.20
8.	Barnyard millet	6.20	2.20	65.50	307.00	20.00	280	5.00	82.00	-	-	9.80

Value Added Products from Multi Millet

- Standardization of multi millet based food products
 - Finger millet,
 - Little millet,
 - Kodo millet,
 - Foxtail millet and
 - Barnyard millet
- Value added products
 - Traditional foods,
 - Bakery foods,
 - Extruded foods and
 - Instant food mixes.

- Studying the acceptability of the standardized food products by using 9 point hedonic scale
- Analysis of nutrient content of the food products

➤ Carbohydrate	➤ Calcium
➤ Protein	➤ Iron
➤ Fat	➤ Thiamine
➤ Fibre	➤ Riboflavin

Multi millet food products



Sensory Evaluation of Multi Millet Foods

	Name of the Product	Colour and Appearance	Flavour	Texture	Taste	Overall Acceptability
BREAK FAST FOODS						
1	Idli	8.4±0.32	8.4±0.21	8.5±0.20	8.4±0.14	8.5±0.14
2	Dosa	8.5±0.07	8.7±0.12	8.4±0.14	8.5±0.16	8.6±0.14
3	Idiappam	8.2±0.25	8.2±0.11	8.3±0.11	8.5±0.06	8.5±0.16
4	Paniyaram	8.6±0.22	8.6±0.08	8.6±0.10	8.5±0.11	8.6±0.21
5	Pittu	8.2±0.12	8.3±0.10	8.4±0.21	8.4±0.12	8.4±0.46
6	Adai	8.8±0.33	8.8±0.34	8.6±0.13	8.6±0.14	8.7±0.23
7	Chappathi	8.8±0.41	8.7±0.18	8.7±0.18	8.6±0.16	8.8±0.25
8	Venpongai	8.8±0.21	8.8±0.15	8.8±0.14	8.8±0.18	8.8±0.20
SWEET PRODUCTS						
9	Sweet pongal	8.8±0.41	8.6±0.05	8.7±0.12	8.8±0.06	8.8±0.02
10	Halwa	8.4±0.15	8.5±0.06	8.6±0.11	8.4±0.05	8.5±0.06
11	Sweet Kolukattai	8.2±0.10	8.2±0.10	8.4±0.14	8.5±0.04	8.4±0.04
12	Payasam	8.7±0.12	8.6±0.07	8.7±0.08	8.7±0.04	8.7±0.08
13	Adhirasam	8.3±0.19	8.4±0.09	8.4±0.14	8.5±0.02	8.6±0.04
14	Kesari	8.6±0.14	8.7±0.10	8.7±0.05	8.7±0.06	8.7±0.10

Values are mean ± SD

Sensory Evaluation of Multi Millet Foods

	Name of the Product	Colour and Appearance	Flavour	Texture	Taste	Overall Acceptability
	LUNCH					
15	Tomato rice	8.4±0.12	8.3±0.14	8.4±0.14	8.4±0.14	8.5±0.12
16	Methi rice	8.4±0.11	8.2±0.15	8.6±0.09	8.3±0.12	8.4±0.14
17	Bisbellabath	8.5±0.07	8.4±0.16	8.5±0.10	8.4±0.15	8.6±0.16
18	Tamarind rice	8.5±0.08	8.6±0.16	8.6±0.12	8.3±0.11	8.5±0.12
19	Biriyani	8.3±0.10	8.3±0.14	8.4±0.10	8.4±0.10	8.6±0.14
	SNACKS					
20	Vadai	8.2±0.04	8.3±0.16	8.4±0.23	8.5±0.014	8.4±0.12
21	Pakoda	8.4±0.02	8.4±0.14	8.4±0.24	8.4±0.06	8.4±0.08
22	Ribbon pakoda	8.6±0.03	8.7±0.08	8.5±0.18	8.6±0.08	8.6±0.04
23	Omapodi	8.4±0.04	8.3±0.10	8.4±0.14	8.4±0.10	8.3±0.32
24	Murukku	8.5±0.08	8.4±0.24	8.4±0.09	8.5±0.12	8.5±0.26
25	Thattuvadai	8.5±0.06	8.3±0.04	8.4±0.32	8.5±0.14	8.5±0.22
26	Seedai	8.6±0.10	8.5±0.18	8.4±0.16	8.5±0.18	8.5±0.18

Values are mean ± SD

Sensory Evaluation of Multi Millet Foods

	Name of the Product	Colour and Appearance	Flavour	Texture	Taste	Overall Acceptability
	BAKERY					
27	Bread	8.6±0.06	8.4±0.04	8.5±0.06	8.7±0.01	8.6±0.04
28	Bread roll	8.5±0.08	8.4±0.02	8.4±0.08	8.5±0.01	8.5±0.14
29	Bun	8.4±0.06	8.4±0.06	8.4±0.04	8.4±0.03	8.5±0.12
30	Cookies	8.7±0.02	8.8±0.08	8.6±0.12	8.7±0.02	8.8±0.14
31	Cake	8.4±0.04	8.3±0.04	8.4±0.16	8.5±0.05	8.5±0.16
32	Dough nut	8.6±0.12	8.4±0.02	8.4±0.12	8.5±0.06	8.6±0.12
33	Khari	8.5±0.14	8.2±0.14	8.5±0.12	8.4±0.12	8.3±0.18
34	Soup stick	8.5±0.10	8.2±0.12	8.3±0.10	8.2±0.16	8.2±0.10
	Extruded and flaked products					
35	Flaked upma	8.4	8.3	8.4	8.6	8.5
36	Vermiceli	8.2	8.2	8.3	8.3	8.3
	Ready to cook mixes					
37	Halwa mix	8.5±0.17	8.4±0.16	8.6±0.10	8.4±0.50	8.6±0.16
38	Payasam mix	8.7±0.10	8.6±0.12	8.7±0.04	8.7±0.02	8.7±0.14
39	Ribbon pakoda	8.5±0.30	8.7±0.18	8.5±0.28	8.6±0.18	8.6±0.22
40	Omapodi	8.5±0.14	8.4±0.16	8.5±0.20	8.5±0.16	8.4±0.20
41	Murukku	8.6±0.38	8.5±0.40	8.5±0.09	8.4±0.10	8.5±0.01
42	Vadai	8.3±0.01	8.2±0.10	8.4±0.30	8.5±0.14	8.3±0.10
43	Vadagam	8.6±0.06	8.3±0.12	8.3±0.13	8.4±0.32	8.4±0.18
44	Health mix	8.7±0.02	8.6±0.01	8.7±0.10	8.6±0.16	8.8±0.10

Nutritive value of multi millet products (per 100g)

S.No	Items	Energy (K.cal)	Protein (g)	Fat (g)	Carbohydrate (g)	Fibre (g)	Calcium (mg)	Iron (mg)
BREAK FAST FOODS								
1	Idli	273.32	12.86	2.88	63.07	3.64	55.51	4.28
2	Dosa	283.41	12.64	2.52	64.10	3.94	98.84	4.26
3	Paniyaram	239.67	11.25	4.64	54.27	3.12	97.51	3.95
4	Idiyappam	329.64	5.19	1.83	60.24	2.30	16.13	2.64
5	Pittu	322.49	6.00	1.08	61.36	3.28	68.28	3.45
6	Adai	301.99	13.68	2.37	62.64	4.97	128.32	4.22
7	Chappathi	255.33	8.57	2.75	61.42	6.72	110.00	4.30
8	Venpongal	309.94	14.86	7.32	55.81	4.65	100.08	4.76
SWEET PRODUCTS								
9	Sweet pongal	289.51	9.58	13.88	61.76	3.72	45.35	3.74
10	Halwa	323.80	7.40	6.50	62.30	3.13	140.58	2.10
11	Sweet kolakattai	324.84	7.50	6.39	64.30	2.13	142.58	4.01
12	Payasam	264.91	5.04	4.06	59.72	3.56	50.35	3.25
13	Adhirasam	356.30	4.41	10.01	86.93	2.33	67.64	2.79
14	Kesari	373.65	4.14	13.64	63.16	2.40	75.99	3.04

Nutritive value of multi millet products (per 100g)

S.No	Items	Energy (K.cal)	Protein (g)	Fat (g)	Carbohydrate (g)	Fibre (g)	Calcium (mg)	Iron (mg)
LUNCH								
15	Tomato rice	143.76	5.42	1.73	36.24	5.10	40.17	3.76
16	Methi rice	218.94	7.80	4.95	48.43	6.29	37.77	3.62
17	Bisellabath	214.97	8.54	2.98	50.04	5.81	32.08	6.55
18	Tamarind rice	229.76	7.15	2.78	52.59	5.83	40.30	4.46
19	Biryani rice	193.86	7.66	2.29	47.17	6.67	55.28	7.28
SNACKS								
20	Vadai	229.76	7.15	2.78	52.59	5.83	40.30	4.46
21	Pakoda	193.86	7.66	2.29	47.17	6.67	55.28	7.28
22	Ribbon pakoda	284.22	7.98	7.44	60.22	3.10	105.32	4.19
23	Muruku	289.82	8.20	12.06	59.25	3.07	151.03	5.09
24	Omapodi	370.03	8.06	7.45	66.56	3.55	78.44	3.89
25	Thatuvadai	272.00	10.28	6.48	62.24	3.50	94.44	4.23
26	Sedai	303.09	9.90	10.97	70.68	2.74	97.08	3.87

Nutritive value of multi millet products (per 100g)

S.No	Items	Energy (K.cal)	Protein (g)	Fat (g)	Carbohydrate (g)	Fibre (g)	Calcium (mg)	Iron (mg)
BAKERY								
27	Bread	310.45	10.54	2.91	88.52	1.76	48.76	3.47
28	Bread Roll	348.76	12.47	1.28	72.37	1.76	35.16	3.02
29	Bun	329.79	11.01	1.24	82.01	1.76	56.56	3.06
30	Cookies	396.01	9.71	34.24	74.93	2.95	56.40	3.54
31	Cake	418.30	8.58	24.93	48.98	1.54	22.20	1.12
32	Dough nut	361.60	13.78	1.41	68.68	2.38	43.90	2.21
33	Khari	310.45	10.54	2.91	88.52	1.76	48.76	3.47
34	Soup stick	348.76	12.47	1.28	72.37	1.76	35.16	3.02
Extruded and flaked products								
35	Flaked upma	255.33	8.57	2.75	61.42	6.72	110.00	4.30
36	Vermiceli	287.67	9.15	2.22	68.55	3.41	65.56	3.82
Ready to cook mixes								
37	Halwa mix	377.34	4.35	6.37	64.51	2.73	48.63	1.89
38	Payasam mix	342.01	5.69	2.16	78.18	3.92	65.55	2.92
39	Murukku mix	312.91	9.95	2.05	58.78	3.14	123.23	4.47
40	Ribbon pakoda Mix	309.91	9.45	3.05	58.78	3.14	143.23	4.43
41	Omapodi mix	294.87	12.09	3.63	64.32	2.68	75.46	4.60
42	Vada mix	275.01	11.56	3.40	58.87	2.28	94.93	4.32
43	Vadagam	254.89	8.60	3.28	61.61	2.78	130.92	4.68
44	Health mix	382.90	12.91	5.52	81.08	6.36	127.49	5.19

Standardization of Multi Millet Based Therapeutic Foods

❖ Breakfast

- Multi millet drumstick leaves dosa
- Multi millet drumstick leaves chappathi
- Multi millet vegetable rotti

- Multi millet palak dosa
- Multi millet idiyappam
- Multi millet adai

- Multi millet uppma
- Multi millet kitchadi

Flour of multi millets

Grits of multi millets

❖ Lunch

- Multi millet palak rice
- Multi millet methi rice

Millet rice

Multi millets based therapeutic foods



Nutritive value of multi millet based therapeutic foods

(Per 100 g)

Sl. No	Item	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Crude fibre (g)	Calcium (mg)	Iron (mg)	Beta carotene (µg)
1.	Multi millet based drumstick leaves dosa mix	309.90	60.54	11.99	2.22	10.12	132.60	4.07	215.03
2.	Multi millet based drumstick leaves chapatti mix	316.91	64.07	10.08	2.36	4.64	41.76	4.21	125.57
3.	Multi millet based vegetable rotti mix	242.27	51.22	6.13	1.71	4.05	64.73	2.69	262.75
4.	Multi millet kitchadi mix	213.73	38.91	6.14	4.07	4.94	37.58	2.97	291.84
5.	Multi millet palak leaves dosa mix	309.08	58.59	12.70	2.67	5.67	77.39	3.87	191.97

Nutritive value of multi millet based therapeutic foods

(per 100 g)

Sl. No	Item	Energy (Kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Crude fibre (g)	Calcium (mg)	Iron (mg)	Beta carotene (μ g)
6.	Multi millet palak leaves rice mix	240.15	37.16	6.36	7.50	4.65	44.38	3.00	910.83
7.	Multi millet fenugreek leaves rice mix	244.61	37.76	6.82	7.54	4.74	105.56	3.14	395.02
8.	Multi millet uppma mix	285.22	43.21	6.43	9.63	5.29	43.27	4.00	159.53
9.	Multi millet idiyappam mix	316.74	64.94	8.19	2.72	6.84	85.16	4.00	13.91
10.	Multi millet adai mix	312.84	59.58	13.26	2.41	4.80	124.64	4.37	194.96

Microbial Analysis of Therapeutic foods

Sl. No.	Samples	Yeast and Mold	E. Coli	Total plate count	Remarks
1	Multi millet drumstick leaves dosa mix	Nil	Nil	3.09×10^5	Within the safer limits
2	Multi millet drumstick leaves chappathi mix	Nil	Nil	2.04×10^5	Within the safer limits
3	Multi millet vegetables rotti mix	Nil	Nil	2.77×10^5	Within the safer limits
4	Multi millet kitchadi mix	Nil	Nil	5.04×10^5	Within the safer limits
5.	Millet millet palak leaves dosa mix	Nil	Nil	2.31×10^5	Within the safer limits
6.	Multi millet palak leaves rice mix	Nil	Nil	2.77×10^5	Within the safer limits
7.	Multi millet fenugreek leaves rice mix	Nil	Nil	4.59×10^5	Within the safer limits
8.	Multi millet uppma mix	Nil	Nil	3.04×10^5	Within the safer limits
9.	Multi millet idiyappam mix	Nil	Nil	4.27×10^5	Within the safer limits
10.	Multi millet adai mix	Nil	Nil	4.13×10^5	Within the safer limits

Bioavailability studies

Bioavailability studies of multi millet cookies

- Studying the bioavailability of nutrient contents of cookies
- Group A - Control
- Group B - Multi millet cookies fed.
- Collection of blood samples
- Nutrients Analysed in blood plasma: carbohydrate, fat, protein, calcium, iron, thiamine and riboflavin.



Bioavailability studies- findings

- Higher absorption of calcium, thiamine, riboflavin and iron.
- Delay in carbohydrate absorption.
- The absorption of minerals & water soluble vitamins are better
- The millet food products had higher amounts of phytochemicals (fibre, iron, calcium & beta-carotene)



Control cookies

Multi millet cookies



Bioavailability studies - Multi millet based therapeutic foods

Studied in the wister rats at 0, 1, 2, 4 and 8 hours of post dose period.

Result

- Higher absorption of
 - Carbohydrate and protein - after 2 hours
 - Fat after 4 hours.
 - Vitamins (thiamine and riboflavin) - after 2 hours and
 - Minerals (calcium and iron) - after 2 hours

Bioavailability Studies - Multi Millet Instant Mixes

T ₀	Control
T ₁	Multi millet adai mix
T ₂	Multi millet kichadi mix
T ₃	Multi millet drumstick leaves dosa mix
T ₄	Multi millet palak leaves dosa mix
T ₅	Multi millet fenugreek leaves rice mix
T ₆	Multi millet drumstick leaves chappathi mix
T ₇	Multi millet vegetable rotti mix
T ₈	Multi millet palak leaves rice mix
T ₉	Multi millet upma mix
T ₁₀	Multi millet idiyappam mix

- Group A fed - Control
- Group B fed - Multi millet instant mixes.
- Collection of blood samples
- Nutrients Analysed in blood : carbohydrate, fat, protein, calcium, iron, thiamine and riboflavin

Findings

- Higher absorption of
 - Carbohydrate and protein - after 2 hours
 - Fat after 4 hours.
 - Vitamins (thiamine and riboflavin) - after 2 hours
 - Minerals (calcium and iron) - after 2 hours

ANTI DIABETIC STUDIES

Glycemic Index of small millet flours

Flour	GI value
Refined wheat flour	71.33
Kodo millet flour	43.91
Little millet flour	41.42
Foxtail millet flour	41.04

Mean glucose concentration present in the plasma of rats (mg/dl)

S.No	Treatments	Time intervals (hrs)				
		0	1	3	7	15
T ₀	Control	113.67	302.67	293.67	281.83	276.83
T ₁	Diabetic control	113.67	313.00	242.50	234.67	232.83
T ₂	Multi millet drumstick leaves chappathi mix	152.50	316.00	294.17	193.50	140.00
T ₃	Multi millet vegetable rotti mix	129.67	344.50	263.33	237.00	176.33
T ₄	Multi millet palak leaves rice mix	100.00	304.67	285.17	248.17	193.50
T ₅	Multi millet upma mix	121.17	304.17	224.50	179.00	166.83
T ₆	Multi millet idiyappam mix	113.17	313.50	266.50	240.17	239.17
T ₇	Multi millet adai mix	110.83	316.17	243.50	163.50	166.83
T ₈	Multi millet drumstick leaves dosa mix	144.83	352.83	252.83	178.17	173.83
T ₉	Multi millet kichadi mix	100.00	304.67	253.50	186.00	179.00
T ₁₀	Multi millet palak leaves dosa mix	121.17	304.17	244.50	179.17	176.83
T ₁₁	Multi millet fenugreek leaves rice mix	113.17	313.50	266.50	160.17	152.50

Findings

- Significant reduction in the blood glucose level after sever hours.
- Among the products,
 - Multi millet drumstick leaves chappathi mix
 - Multi millet fenugreek leaves rice mix,
 - Multi millet upma mix and
 - Multi millet adai mix

PUBLICATIONS

1. Malathi, D., Gurumeenakshi, G. and padma, A.2016. Millet incorporated bakery foods. *Indian Farming*. 65(12):75-76.March 2016.
2. Varadharaju, N., Malathi, D. and Ganesan, S. 2016. Dehuller for millets. *Indian Farming* 65(12): 77-78.
3. Senthamarai selvi, S. and Malathi, D. 2016. Standardization and impact of functional products from kodo millet. Presented a paper in National seminar on 'functional foods to achieve nutrition and health security on 19th September 2016 held at Home Science College & Research Institute, Madurai. Pp: 22.
4. Malathi, D. and Padma, A. 2016. Standarization of multimillet cookies. Presented a paper in National seminar on 'functional foods to achieve nutrition and health security on 19th September 2016 held at Home Science College & Research Institute, Madurai. Pp: 97.
5. Malathi.D. 2016. standardization multi millet cookies presented paper in National Seminar on Functional Foods to Achieve Nutrition and Health Security, Home Science College and Research Institute, Tamil Nadu Agricultural University, Madurai& Indian Institute of Crop Processing Technology, Thanjavur. Madurai, Tamil Nadu
6. Senthamarai Selvi, L. 2016. Standardization, and impact of functional products from kodo millet (*Paspalum scrobiculatum*). Presented paper in National Seminar on Functional Foods to Achieve Nutrition and Health Security, Home Science College and Research Institute, Tamil Nadu Agricultural University, Madurai & Indian Institute of Crop Processing Technology, Thanjavur. Madurai, Tamil Nadu

7. Malathi D, Subbulakshmi B, and Padma A, 2017. Development of prebiotic bakery products from millets and xylooligosaccharides. *Journal of Nutrition and Food Sciences*. 7 (3): P.61.
8. Varadharaju N. and Ganesan S. 2017. Effect of parboiling (thermal treatment) on de-hulling and cooking qualities of little millet (*Panicum sumatrense*) and foxtail millet (*Setaria italic*). *Journal of Nutrition and Food Sciences*. 7 (3): P.56.
9. Varadharaju N. and Ganesan S. 2017. Effect of de-hulling process on milling and nutritional quality of millets. *Journal of Nutrition and Food Sciences*. 7 (3): P.33.
10. Padma A., Rajendran, R and Malathi D. 2017. Evaluation of nutritive quality and sensory attributes of mushroom powder fortified millets cookies. National Symposium- Trends in Agricultural and Biosystems engineering (TABE 17), March 27-28, Department of Bio energy, Tamil Nadu Agricultural University, Coimbatore, Pp.319-321.
11. Malathi, D., Padma, A. and Subbulakshmi, B. 2017. Development and quality evaluation of multi millet cookies. *Journal of Nutrition and Food Sciences*. 7 (3): Pp.55.

12. D. Malathi and B. Subbulakshmi. 2018. Formulation and development of instant food mixes based on millets. Presented paper in 2nd International conference on Innovative food and nutrition technologies for public health care, Periyar University, Salem, Tamil Nadu
13. D. Malathi and B. Subbulakshmi. 2018. Glycemic index of selected small millets. Presented paper in 2nd International conference on Innovative food and nutrition technologies for public health care, Periyar University, Salem, Tamil Nadu.
14. D. Malathi and B. Subbulakshmi. 2018. Multi millets based traditional food mixes. Presented paper in International conference on Bridging innovation in sports, education and nutrition, Avinashilingam University, Coimbatore, Tamil Nadu
15. D. Malathi and B. Subbulakshmi. 2018. Nutrients dense multi millets health mix. Presented paper in International conference on Bridging innovation in sports, education and nutrition, Avinashilingam University, Coimbatore, Tamil Nadu
16. Subbulakshmi, B. and Malathi D. 2017. Formulation of multi millet cookies and evaluate its hypoglycaemic effect in albino rats. Journal of Crop and weed. 13(3): 112-116 (2017)