

Shelf-life Enhancement of Pearl Millet Flour





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Nutritive Value of Cereals per 100 gms

Cereals	Protein (g)	Fat (g)	CHO (g)	Minerals (g)	Calcium (g)	Fiber (g)	Energy (kca)
Rice (raw)	6.8	0.5	78.2	0.6	10	0.2	345
Rice (Parboiled)	8.5	0.6	77.4	0.9	10	0.2	349
Rice bran	13.5	16.2	48.4	6.6	67	4.3	393
Wheat Whole	11.8	1.5	71.2	1.5	41	1.2	346
Wheat Flour	12.1	1.7	69.4	2.7	48	1.9	341
Maida	11.0	0.9	73.9	0.6	23	0.3	348
Bajra	11.6	5.0	67.5	2.3	42	1.2	361
Jowar	10.4	1.9	72.6	1.6	25	1.6	349
Ragi	7.3	1.3	72.0	2.7	344	3.6	328

- Inspite of the fact that pearl millet has high nutritive value, pearl millet and its products are not acceptable in regular diet.
- Regarded as inferior or coarse grain.
- It may be due to its specific odour, colour and coarseness.

Macro and Micro Nutrients in Millets

Millet	Major minerals (g/100g)					Ca: P ratio	Trace metals (mg/100g)			
	K	Na	Mg	Ca	P		Mn	Zn	Cu	Fe
Common millet	0.37	0.06	0.12	0.03	0.26	1:8	19	11	4	20
Finger millet	0.57	0.07	0.13	0.24	0.24	1:1	5	2	4	5
Foxtail millet	0.40	0.08	0.10	0.03	0.27	1:9	26	9	3	19
Pearl Millet	0.307	0.0109	0.137	0.042	0.296	1:7	1.15	3.1	1.06	8
Sorghum	0.131	0.007	0.171	0.025	0.222	1:12	0.78	1.6	0.46	4.1

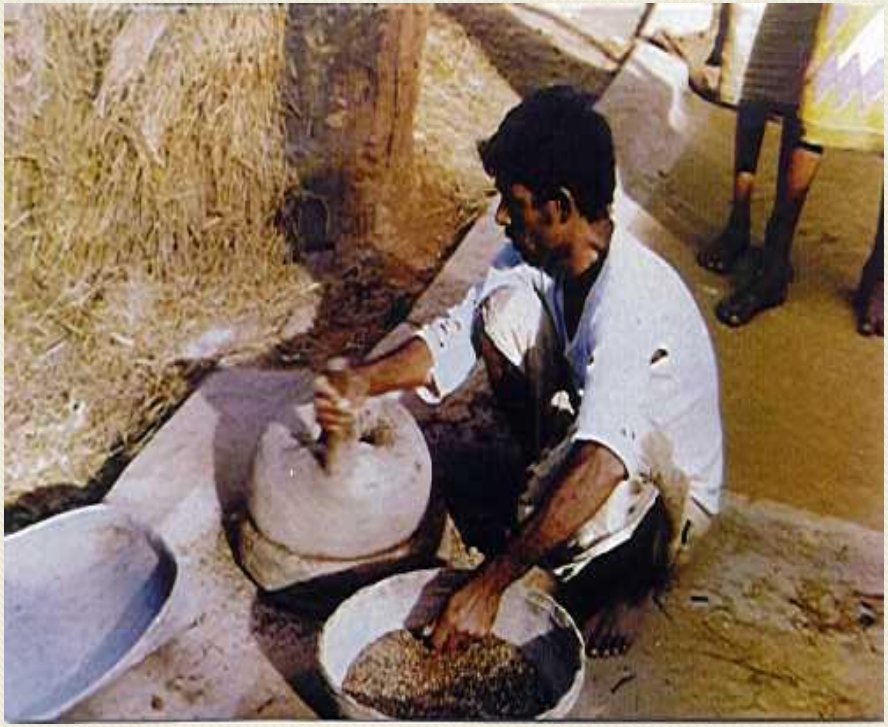
Issues Related to use of Millets

- Millets contain certain anti-nutritional factors like phytate, trypsin inhibitor, oxalates, phenols and tannins
- Presence of pigments & thick pericarp result into poor colour and poor mouthfeel in developed products
- Non-availability and short shelf-life of primary processed products like grits, flakes, semolina and flour
- Lack of ready-to-use processed foods based on millets
- Lack of awareness of nutritional and therapeutic potential of millets

Functionality of Pearl millet

- Remarkably rich in protein 17.1%, oil (32%) and ash-10.4%. Source: FAO
- The germ fraction is relatively large i.e. 16% (soghum-10%).
- Practically all oil (87%) of whole kernel is in germ fraction which also account for over 72% of the total mineral matter.
- It has high nutritive value but it is not in regular diet among urban inhabitants due to its specific odour, colour, coarseness.
- Further, poor shelf life of the pearl millet flour refrains its consumption on a large scale.
- Therefore efforts are needed for the development of processing techniques to harness nutritional potential of pearl millet based functional foods

Traditional milling equipment bajra-traditional dehulling equipment



- Mostly, women do traditional milling and decorticating of millet.
- prepare the milling products and cook them freshly every day, because keeping quality of flour is low.

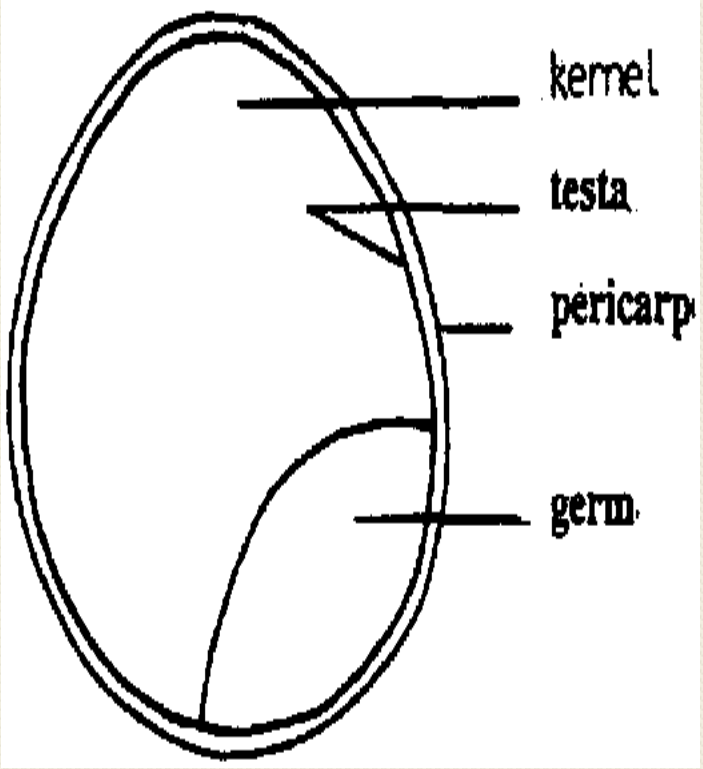
Pounding grains using mortar and pestle



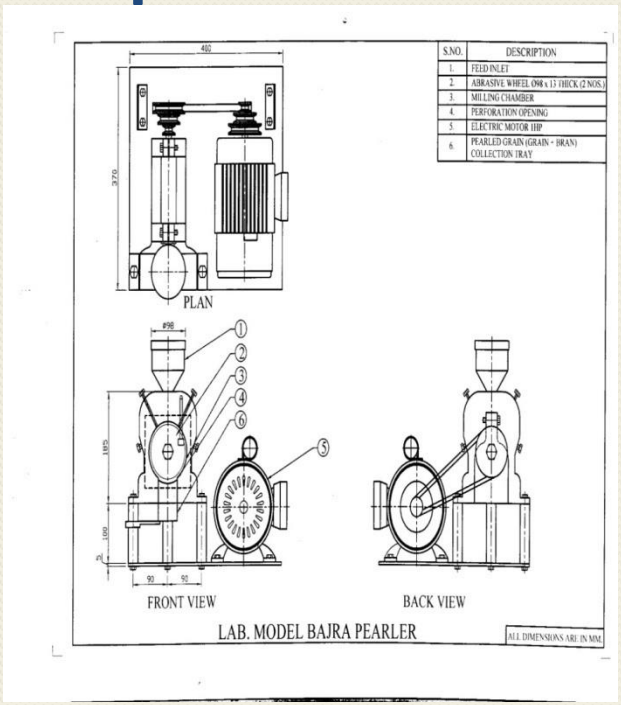
- Pearl millet is usually milled daily in small quantity. Water is added to moisten the pericarp, and facilitate bran removal. The moisture often promotes fermentation and microorganism growth, both of which affect the keeping properties of the products. In addition, the high oil content of the of pearl millet can lead to rancidity problems

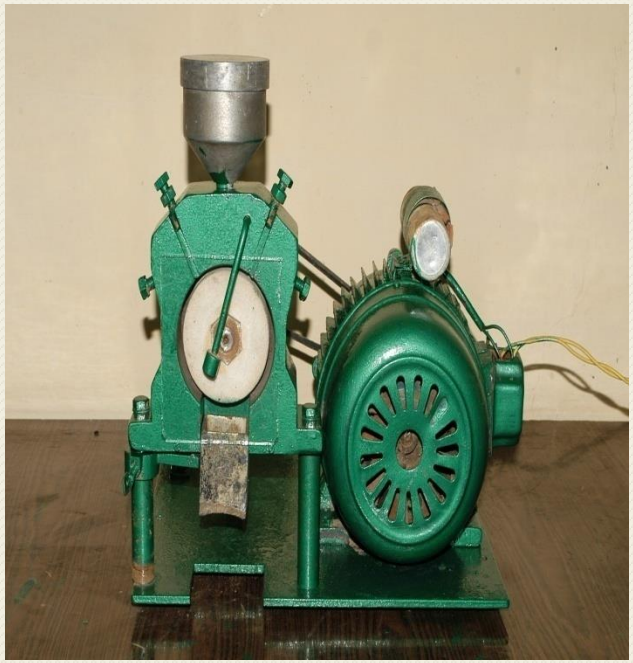
Grain Structure

- The pearl millet grain comprises about
- Pericarp-8%
- Germ-17%
- Endosperm-75%
- Thin waxy cutin layer covers the surface of the pericarp. Beneath the pericarp is a thin layer of seed coat and then single aleurone layer.



Development of Pearler





A pearler is developed which could pearl small quantity of sample. The mill rotors consist of two 98 mm diameter and 13 mm thick carborundum grinding wheels driven by 1.0 hp electric motor. Each wheel is separated by 5 mm where clearance of 2.5mm is maintained between two wheels and pearling chamber. The grain is fed through the top and passes through rotating wheels. The pearled grain is collected at the bottom.

Unit Operations: Machines: Processing of Pearl millet: Fractions

- For better acceptability and longer shelf life the quality of pearl millet flour necessitated pearling of grain.
- Reduction in fat content of pearl millet grain can improve its palatability as well as storability.
- A pearler was developed for removal of the outer bran layer or glumes of the grain.
- Pearling of the pearl millet grain was carried out and the pearled product was used to make flour









Different fractions (pearled grains, partially pearled grains, partially pearled grains-fines, grit and fine bran) obtained were analysed.

Fractions of Bajra Samples









Analysis of Different Fractions

s. No	Fractions	**Ash Contents (Minerals)**	**Crude Protein**	**Either Extract (Lipid)**
1	Bajra (Whole grain	1.35	12.51	10.21
2	Bajra (Pearled grain)	1.92	11.61	9.65
3	Grits	4.28	18.91	17.09
4	Bran	3.11	19.07	15.82

Table 1: Effect of pearling on changes in lipids of pearled pearl millet flour during storage

Treatment	Number of Days			
	7	14	21	28
Fat acidity (mg KOH /100g meal)				
Unpearled (control)	4.5	15.2	40.1	78.9
Pearled	2.3	6.3	21.7	36.6
Free fatty acid (%)				
Unpearled (control)	2.3	7.6	20.1	39.6
Pearled	1.2	3.2	10.9	18.4

Effect of Temperature on Changes in Lipid of Pearl Millet Flour during Storage

Days	Ambient/ Refrigerated condition	Fat acidity or Acid value Mg KOH/kg		FFA %		PV Meq/kg	
		T1	T2	T1	T2	T1	T2
0	Ambient	4.62	11.09	2.32	5.57	16.39	16.66
10	Ambient	7.25	20.93	3.64	10.52	27.52	16.24
10	Refrigerated	4.62	11.09	2.32	5.57	33.06	25.33
20	Ambient	13.87	40.7	6.44	20.4	20.95	11.06
20	Refrigerated	4.62	11.09	2.32	5.57	33.44	21.06

T1 Flour from Pearled Grain
T2 Unpearled (control)

Valuable by-product in Pearling

- The bran fraction that is derived from the pearling process is quite valuable as a by-product.
- Bran is a good source of oil.
- Deoiled bran can be utilized cattle and poultry feeds.

Unit Operation for Making Bajra Baked Products



Bajra

↓

Cleaning (Grain Cleaner)

↓

Pearling (Pearler)

↓

Size Reduction (Burr Mill)

↓

Blending (Manual)

↓

Kneading (Manual)

↓

Rolling (3-4 mm thick)

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Moulding (25 mm Φ)

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Cooling (Rom temperature 8-10 min)

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Bajra Baked Product



Product Development







Pearled Bajra into Flour

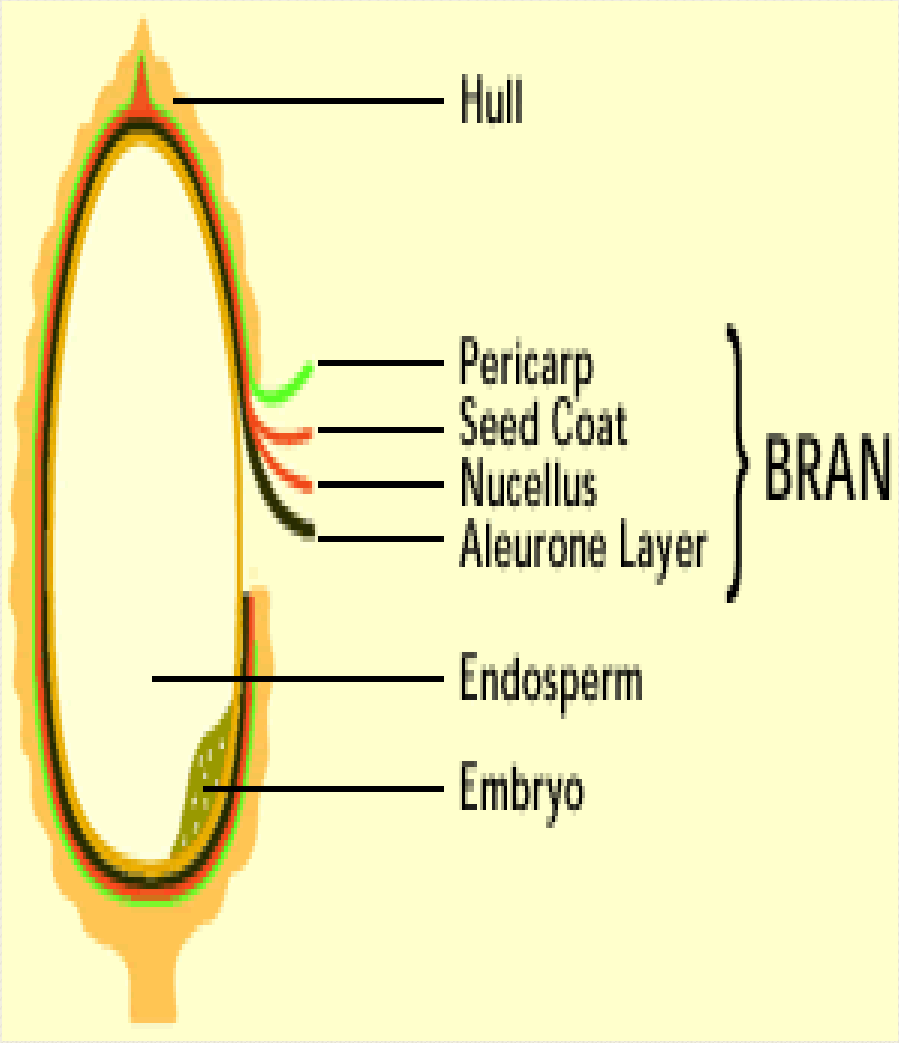








Bran oil



- The structure of the grain kernel is illustrated in Fig. The bran fraction, which includes the germ or embryo in most commercial milling operations, represents only about 8% of grain weight but contains about three-fourths of the total oil (Juliano and Bechtel, 1985; Lu and Luh, 1991). Containing about 15-20% oil (the same general range of soybeans), bran is commercially feasible for oil extraction.

Table 4. Saturated- and unsaturated-fatty acid contents (% of total lipid) of various fractions of *bajra* kernel, its milling products and some edible oils

Sr. No.	Sample Identity	Total Saturated, % of total fatty acids	Total Unsaturated, % of total fatty acids	Total Mono-unsaturated fatty acids	Total Poly-unsaturated fatty acids	Poly-unsaturated fatty acids, % of IV
I	II	III	IV	V	VI	VII
1	Kernel	23.45	76.55	27.66	48.9	63.9
2	Pearled	22.75	77.25	28.15	49.1	63.6
3	Fine Grit	23.95	76.04	26.78	49.3	64.8
4	Coarse Grit	22.66	77.34	27.84	49.5	64.0
5	Bran	24.72	75.27	26.48	48.8	64.8
6	Average	23.51 ±0.38	76.49 ±0.39	27.38 ±0.32	49.12 ±0.13	64.21 ±0.25
7	Rice bran oil	25	75	38	37	28
8	Corn oil	12.95		28	54.68	
9	Cotton seed oil	25.9		19	51.9	
10	Soy bean oil	15.65		24	57.74	

Table 5. Individual fatty acid contents (% of total lipid) of various fractions of *bajra* kernel, its milling products and some edible oils

Sr. No.	Sample Identity	Iodine Value (Wij's Method)	FATTY ACID COMPOSITION					
			Palmitic[1] (C16)	Stearic[2] (C18)	Arachidic[3] (C 20)	Oleic, ω-9 (C18: 1*)	Linoleic ω-6 (C18: 2, n-6)**	Linolenic ω-3 (C18:3 n-3)
1	Kernel	109.71	19.9	3.55	0.66	27.66	46.13	2.1
2	Pearled	105.45	19.47	3.28	0.46	28.15	46.87	1.77
3	Fine Grit	110.83	20.4	3.55	0.85	26.78	46.48	1.93
4	Coarse Grit	109.15	19.34	3.32	0.71	27.84	47.21	1.58
5	Bran	110.14	20.57	4.15	0.91	26.48	45.25	2.63
6	Average	109.06 ±0.94	19.94 ±0.24	3.57 ±0.16	0.72 ±0.08	27.38 ±0.32	46.39 ±0.34	2.00 ±0.18
7	Rice bran oil	99-108	21.5	2.9		38	34.4	2.2
8	Corn oil					28	58	1
9	Cotton seed oil					19	54	1
10	Soy bean oil					24	54	7

[1] Hexadecanoic acid; [2] Octadecanoic acid; [3]Eicosanoic acid; *all-cis-9-octadecenoic acid;**all-

Table 6. Macro-mineral content (g/100 g DM) of *bajra* kernel, its milling products and *bajra*/wheat-bran feed blocks

Food/feed product (Serial-/sample code)	Calcium	Phos-phorus	Ca: P ratio	P: Ca ratio	Magn e-sium	Potass -ium	Sodium
Kernel	0.09	0.20	2: 4.4	1: 0.46	0.11	0.20	0.03
Pearled	0.07	0.23	2: 6.2	1: 0.32	0.07	0.08	0.004
Fine Grit	0.07	0.45	2: 13.2	1: 0.15	0.21	0.45	0.02
Coarse Grit	0.11	0.48	2: 8.8	1: 0.23	0.24	0.61	0.03
Bran	0.05	0.32	2: 12.6	1: 0.16	0.13	0.67	0.05
Mean±SE	0.09 ±0.01	0.34 ±0.06	2: 9.0 ±1.7	1: 0.26 ±0.06	0.15 ±0.03	0.40 ±0.11	0.03 ±0.008
Critical values	0.21-0.52	0.16-0.37	02:01	01:02	0.04-0.08	0.5	0.04-0.10
MNBs							
BB[1]+WB[2] block (15/427)	2.54	0.53	4.77	0.21	0.54	0.69	3.32
BB+WB block (8/429)	2.49	0.37	6.66	0.15	0.54	0.74	2.95
WB block (11/327)	3.83	0.31	12.57	0.08	0.54	0.83	1.69

[1]Bajra bran; [2]Wheat bran.

Table 7. Essential micro-mineral content (ppm) of *bajra* kernel, its milling products and *bajra*/wheat-bran feed blocks

Food/feed product (Serial-/sample code)	Essential micro-minerals						
	Cobalt	Chro-mium	Copper	Iron	Manga-nese	Molyb-denum	Zinc
Kernel	8.30	4.81	3.70	1631.90	13.20	602.8	48.3
Pearled grain	5.50	8.83	2.30	23.80	0.19	377.6	15.8
Fine Grit	10.60	7.96	4.30	92.60	16.40	573.9	44.5
Coarse Grit	11.00	11.80	3.70	63.10	7.40	673.4	33.7
Bran	2.40	11.30	2.10	26.50	12.70	480.8	23.2
Mean±SE	7.56 ±1.62	8.94 ±1.26	3.22 ±0.43	367.58 ±316.34	9.978 ±2.84	541.7 ±51.36	33.1 ±6.16
Critical values	0.1		5	0.10-0.30	20-40	0.5	35-50
MNBs							
BB[1]+WB[2]block (15/427)	26.1	13.4	60.5	996.8	126.3	478.4	270
BB+WB block (8/429)	17.4	11.6	57.9	1402.9	128.9	687.3	267
WB block (11/327)	17.4	9.52	46.2	627.1	139.5	594.7	222

[1]Bajra bran; [2]Wheat bran.

Table 8. Non-essential micro-mineral content (ppm) of *bajra* kernel, its milling products and *bajra*/wheat-bran feed blocks

Food/feed product	Non-essential micro-elements				
	Aluminium	Boron	Cadmium	Nickel	Lead
Kernel,	709	30.67	23.85	360.6	29.2
Pearled	540.2	21.83	28.85	298.3	3.6
Fine Grit	474	36.98	57.88	421.9	7.1
Coarse Grit	548.2	48.92	41.93	301.8	2.6
Bran	672.7	36.67	59.87	444.9	12.2
Mean ± SE	588.8 ±43.98	35.01 ±4.43	42.48 ±7.32	365.5 ±30.1	10.9 ±4.86
Multi-nutrient feed blocks					
BB[1]+WB[2]block (15/427)	606.4	27.27	59.81	350.6	33
BB+WB block (8/429)	474	46.88	51.75	263	15.3
WB block (11/327)	672.7	50.48	31.86	299.3	32

[1]Bajra bran; [2]Wheat bran.

Recommendations

- **Utilization of pearl millet flour with enhanced shelf life**
- Improvement in the palatability and shelf life of pearl millet flour.
- In pearl millet the quality of flour is improved for its better acceptability and longer shelf life. Pearling of the pearl millet grain can improve its palatability as well as shelf life.
- **Utilization of Pearl Millet Bran for Animal Feed**
- Pearl millet -bran (like wheat bran) can also be used for production of feed blocks for supplementation of critical nutrients to the livestock.
- **High-energy grit fraction**
- The data indicated that grit fraction of pearl millet kernel obtained by the milling has 4.3 % ash contents (minerals), 18.90 % crude protein and 17.0 % either extract (lipid) indicating high-energy food for children.
- **Edible oil from pearl millet bran**
- The data indicated that the oil of *bajra* kernel and its pearling products are comparable with the cottonseed and rice bran oils, and thus can be used as such or after blending with similar type of oils for cooking purposes.

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Conclusion and Futuristic Approach

- Efforts will be made for the development of :

➢ Functional foods by blending pearled coarse grains from arid and semi arid regions for nutritional supplements.

➢ combat malnutrition, anemia and iron deficiency.









Flour (after grinding



Kheech (local preparation



Dalia



Animal feed block (Multi nutri



Oil



Thanks







Any Question