

# High-Iron Mungbean Recipes for North India



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AVRDC—the World Vegetable Center is an international not-for-profit organization committed to ensuring the world's food security through research, development, and training.

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Kiran Bains, Ray-yu Yang, and S. Shanmugasundaram



**AVRDC**

**The World Vegetable Center**

*Dr. Kiran Bains  
preparing a high-iron  
mungbean recipe*



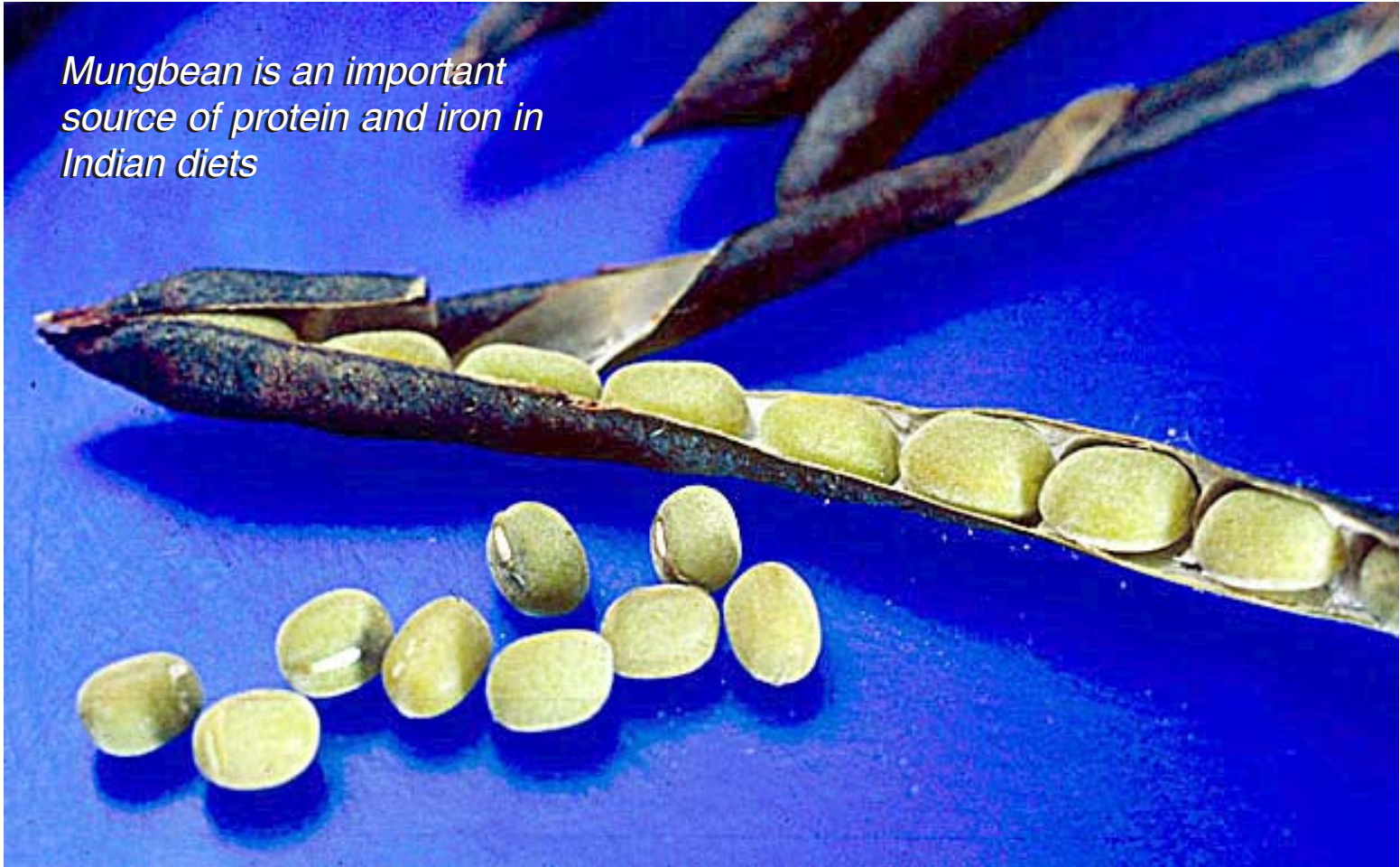


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*Mungbean is an important source of protein and iron in Indian diets*





## Introduction



Mungbean is widely grown and consumed in India. The pulse is an excellent source of protein (20%) and a fair source of iron (4–7 mg per 100 g), but the presence of phytate and tannin in mungbean reduces its iron bioavailability significantly. This loss of nutritional value is critical since iron deficiency anemia is the major micronutrient deficiency problem in India, affecting more than 320 million people. Estimates are that 40–80% of pregnant women, 60–70% of children, and 50% of adolescent girls in India suffer from anemia. Vijayalakshmi et al. (2003) have shown that a food-based approach using improved mungbean recipes is a sustainable way to reduce this nutritional disorder. The bioavailability of iron from mungbean may be enhanced through sprouting (AVRDC, 1994) or by cooking it with vegetables such as tomato and cabbage (AVRDC, 1998). Vegetables exerting iron bioavailability-enhancing effects were further reported by Yang et al. (2002). Subramanian and Yang (1998) have prepared improved mungbean/vegetable recipes for South India. These recipes were developed with an emphasis on simple cooking methods, locally available and inexpensive ingredients, and consumer acceptability.

Although India has achieved self-sufficiency in cereal food grains during the past two decades, there has been a reduction in the production of pulses such as mungbeans. This reduction has resulted in a decline in pulse consumption especially among poor families. The rice-wheat cropping system in the Indo-Gangetic Plains of India is primarily responsible for the enhanced cereal production in India; however, this cropping system has resulted in a number

of problems, including a degradation of soils and increased dependence on chemical fertilizers and pesticides. To overcome these problems, diversification of the system by introducing fast maturing mungbean varieties between two cereal crops or instead of the rice crop has been proposed. The Department for International Development-sponsored project, “Improving income and nutrition by incorporating mungbean in cereal fallows in Indo-Gangetic Plains of South Asia” successfully incorporated short duration mungbean varieties in the rice-wheat cropping system. Such crop diversification enables the farmers to improve their household income and at the same time ensure nutritional security and enrich their soils.

The high-iron recipes developed in this book were prepared to suit the palate of North Indians. The selected ingredients are inexpensive and easily accessible to rural families as well as the urban poor. The iron bioavailability of mungbean has been substantially improved to 7.2–11.3% through cooking practices such as soaking, pressure-cooking, fermenting, sprouting, and using iron- and vitamin C-rich vegetables as ingredients. Iron content of each recipe was determined by the atomic absorption method. Iron bioavailability was measured with the *in vitro* digestion/dialysis method described by AVRDC (1995). The other micronutrient values were referred from the Food Composition Table listed in Huang et al. (1992). The sensory qualities such as flavor and appearance were given due importance in preparing the recipes. By popularizing these recipes among the target population, the iron status of millions of vulnerable families in India can be substantially improved.

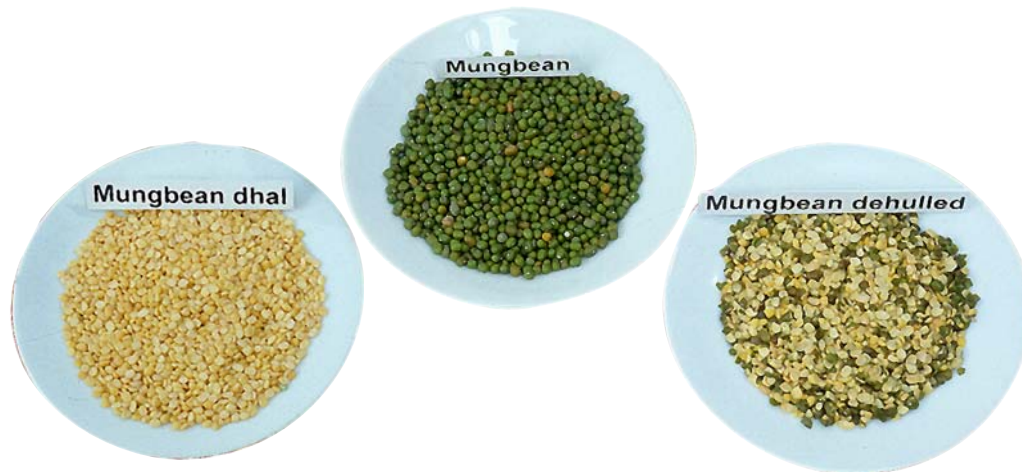


## Terms

Amaranth	<i>Amaranthus viridis</i> , a high-iron leafy vegetable	Mung dhal	Split dehulled mungbean
Coriander	<i>Coriandrum sativum</i> , a high-iron leafy herb	Mungbean	Green gram, <i>Vigna radiata</i> var. <i>radiata</i>
Cumin	<i>Cuminum cyminum</i> , a spice used in the form of seeds	Mustard	<i>Brassica juncea</i> , an herb used in the form of seeds
Curd	Milk cultured with <i>Lactobacillus</i> species; yogurt	Namkeen	Fried and crispy snack prepared from legumes
Dahi bhalla	Fermented and fried ball of mungbean in curd	Pakoda	Fried snack prepared from vegetables coated with legume flour paste
Dhal	Preparations made of split dehulled or whole pulse (see next page)	Parantha	Pancake
Dhuli mung dhal	Cooked dehusked and split mungbean	Poha	Dish prepared from rice flakes and vegetables
Fenugreek	<i>Trigonella foenum-graecum</i> , a locally available leafy vegetable also known as Greek hay	Pulao	Rice cooked with vegetables
Garam masala	Powdered mixture of Indian condiments and spices	Raita	Fermented curd with vegetables and spices
Ghee	Melted butter	Saag	A preparation of leafy vegetables
Iron bioavailability	Iron available to the human body	Sabat	Whole
Khichri	A combination of rice and legume	Tamarind chutney	Sweet and sour preparation made from tamarind fruit in the form of a thick liquid
Mint chutney	Mint leaves ground into thin paste	Turmeric powder	Spice ground from the root of <i>Curcuma longa</i> that gives yellow color to food
		Tawa	Iron pan to make pancakes







Mungbean is commonly sold in three forms: whole mungbean, split dehulled mungbean called mung (or mungbean) dhal, and split dehulled mungbean sold with hulls. Many of the recipes in this book contain mung dhal, which calls for split mungbean with the hulls removed. Some recipes in this book call for mungbean sprouts, which are produced from whole mungbean.

Several of the recipes call for pressure cooking mungbean dhal. When this initial cooking is complete, other ingredients are some-

times added to the same pot and the mix is cooked altogether. Note that pressure is used only for the initial cooking and that subsequent cooking with the combined ingredients does not require pressure unless otherwise indicated.


You will also notice that metric measures are used, but that teaspoon and tablespoon conversions are often supplied in parentheses for convenience. If you wish to convert grams to ounces, you'll find a simple conversion table in Appendix II.





# Dhuli Mung Dhal

## Ingredients:



Mung dhal	:	100 g
Tomato	:	75 g
Onion	:	50 g
Garlic	:	3 to 4 cloves
Oil/ghee	:	20 g
Coriander leaves	:	10 g (1 tbsp)
Cumin seeds	:	¼ tsp
Turmeric powder	:	½ tsp
Salt, to taste	:	
Red chillies, to taste	:	
Garam masala, to taste	:	

## Nutrient composition:

Energy	:	570 kcal
Protein	:	26 g
Calcium	:	200 mg
Iron	:	5.29 mg
(bioavailability 10.20%)	:	
Phosphorus	:	611 mg
β-carotene	:	0.90 mg (150 µg RE)
Thiamine	:	0.69 mg
Riboflavin	:	0.27 mg
Niacin	:	2.55 mg
Ascorbic acid	:	35 mg

Serves three

## Preparation:

1. Wash the mungbean dhal and cook it in a pressure cooker with chopped garlic, turmeric powder, red chillies, salt, and 2½ cups of water for 5 minutes.
2. Fry finely chopped onion in oil/ghee until the onion turns golden brown.
3. Add cumin seeds and sauté for a few seconds.
4. Add chopped/pureed tomatoes. Cook until tomatoes are done and mixture leaves the sides of the pan.
5. Add garam masala to dhal and garnish it with finely chopped coriander leaves.

*A delicious preparation  
that goes well with  
wheat chapaties, salad  
and pickle*





# Sabat Mung Dhal

## Ingredients:

Mung dhal	:	100 g
Tomato	:	75 g
Onion	:	50 g
Garlic	:	4 to 5 cloves
Oil/ghee	:	20 g
Cumin seeds	:	¼ tsp
Turmeric powder	:	½ tsp
Coriander leaves	:	10 g (1 tbsp)
Salt, to taste	:	
Red chillies, to taste	:	
Garam masala, to taste	:	

## Nutrient composition:

Energy	:	584 kcal
Protein	:	26 g
Calcium	:	151 mg
Iron	:	4.79 mg
(bioavailability 8.15%)	:	
Phosphorus	:	481 mg
β-carotene	:	0.90 mg (150 µg RE)
Thiamine	:	0.70 mg
Riboflavin	:	0.30 mg
Niacin	:	3.0 mg
Ascorbic acid	:	35 mg

Serves three

## Preparation:

1. Wash the mungbean dhal and cook it in a pressure cooker with chopped garlic, turmeric powder, red chillies, salt, and 4 cups of water for 5 minutes.
2. Fry finely chopped onion in oil/ghee until the onion turns golden brown.
3. Add cumin seeds and sauté for a few seconds.
4. Add chopped/pureed tomatoes. Cook until tomatoes are done and mixture leaves the sides of the pan.
5. Add garam masala to dhal and garnish it with finely chopped coriander leaves.

*A wholesome  
breakfast meal in  
combination with  
butter and curd*





# Parantha

## Ingredients:

Mung dhal flour	:	50 g
Wheat flour	:	100 g
Spinach/fenugreek leaves	:	50 g
Onion	:	50 g
Oil/ghee	:	20 g
Cumin seeds	:	5 g
Salt, to taste	:	
Chilli powder, to taste	:	

## Nutrient composition:

Energy	:	730 kcal
Protein	:	26 g
Calcium	:	166 mg
Iron	:	8.27 mg
(bioavailability 11.32%)	:	
Phosphorus	:	563 mg
β-carotene	:	1.40 mg (233 µg RE)
Thiamine	:	0.82 mg
Riboflavin	:	0.41 mg
Niacin	:	6.00 mg
Ascorbic acid	:	15 mg

Serves three

## Preparation:

1. Roast the cumin seeds.
2. Finely chop the spinach/fenugreek leaves and onion.
3. Make a dough by mixing together wheat flour, mung dhal flour, spinach/fenugreek leaves, onion, and remaining dry ingredients.
4. Form into round balls.
5. Roast parantha on tawa, applying oil on both sides.



*A light, but nutritious and complete meal, best suited for young children and the elderly*







# Mung Dhal Khichri

## Ingredients:



Mung dhal	:	50 g
Rice	:	100 g
Cauliflower/radish leaves	:	100 g
Onion	:	50 g
Tomato	:	50 g
Green chillies	:	2 to 4 fruits
Oil/ghee	:	20 g
Cumin seeds	:	½ tsp
Salt, to taste	:	

## Nutrient composition:

Energy	:	838 kcal
Protein	:	26 g
Calcium	:	743 mg
Iron	:	8.04 mg
(bioavailability 9.16%)	:	
Phosphorus	:	513 mg
β-carotene	:	1.39 mg (232 µg RE)
Thiamine	:	0.62 mg
Riboflavin	:	0.60 mg
Niacin	:	8.89 mg
Ascorbic acid	:	131 mg

Serves three

## Preparation:

1. Sauté onion in oil/ghee until golden brown in a pressure cooker.
2. Add cumin seeds and finely chopped tomatoes and green chillies.
3. Cook until tomatoes are done and the mixture leaves the sides of the cooker.
4. Wash rice and mung dhal.
5. Wash and chop cauliflower/radish leaves.
6. Add rice, mung dhal, chopped cauliflower/radish leaves, and water (4 cups) to the above mixture in a pressure cooker and cook for 15 minutes.




*An iron-rich dish that can be served in any season*





# Mung Spinach Saag

## Ingredients:



Mung dhal	:	75 g
Spinach	:	300 g
Onion	:	60 g
Tomato	:	75 g
Green chillies	:	2 to 4 fruits
Garlic	:	4 to 5 cloves
Ginger paste	:	1 tbsp
Cumin seeds	:	¼ tsp
Oil/ghee	:	20 g
Salt, to taste	:	

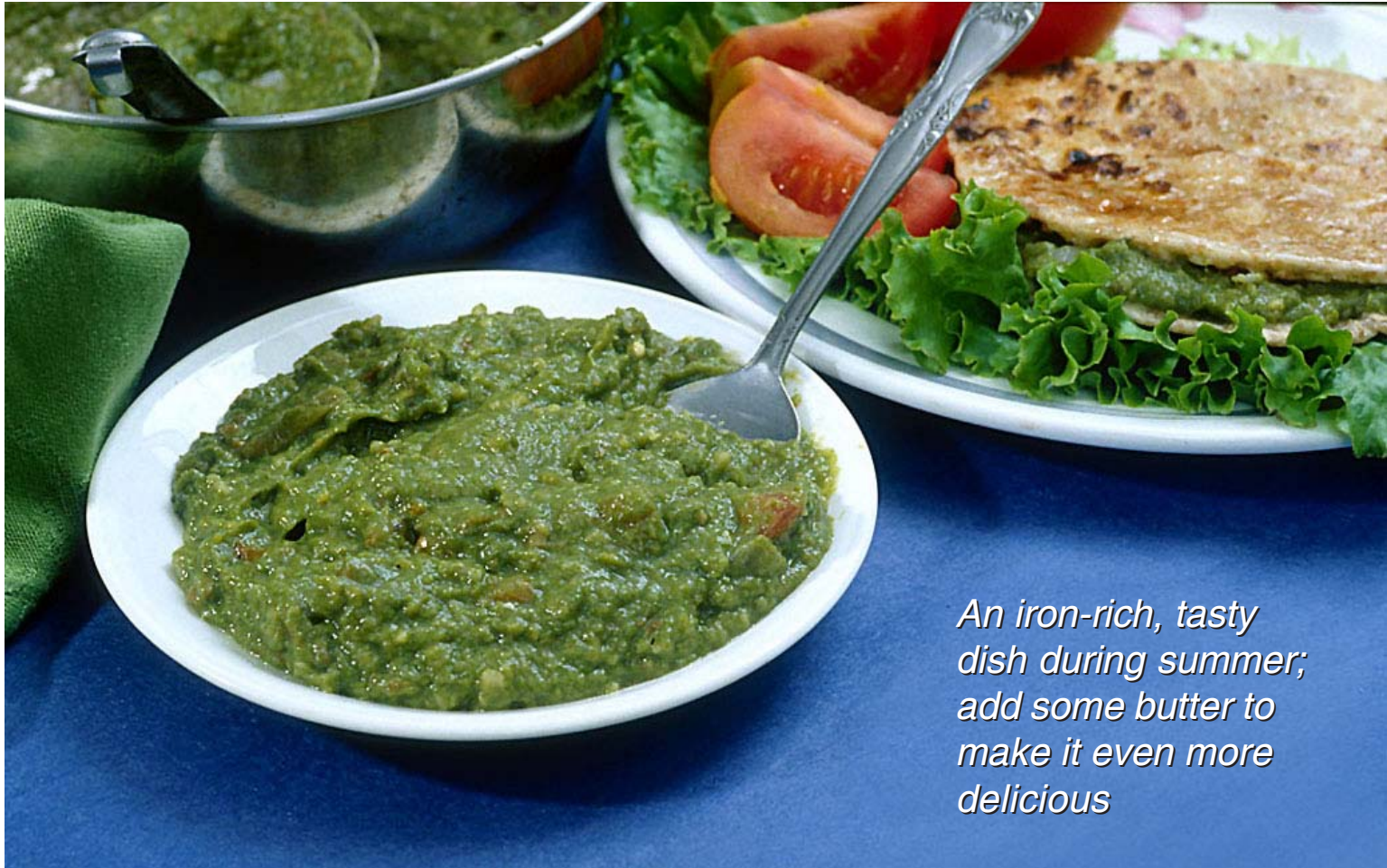
## Nutrient composition:

Energy	:	567 kcal
Protein	:	26 g
Calcium	:	373 mg
Iron	:	8.04 mg
(bioavailability 11.31%)	:	
Phosphorus	:	423 mg
β-carotene	:	8.5 mg (1418 µg RE)
Thiamine	:	0.75 mg
Riboflavin	:	1.10 mg
Niacin	:	5.84 mg
Ascorbic acid	:	131 mg

## Preparation:

Serves three

1. Clean and wash mung dhal and spinach leaves.
2. Finely chop the spinach leaves, garlic, and green chillies.
3. Pressure cook mung dhal with spinach, garlic, green chillies, ginger paste, salt, and water (1 cup) for 10 minutes.
4. Blend the saag into paste manually or by using electric blender.
5. Fry finely chopped onions in oil/ghee until golden brown.
6. Add cumin seeds and chopped/pureed tomatoes. Cook until tomatoes are done and the mixture leaves the sides of the pan.
7. Add saag to this mixture and cook for few more minutes.



*An iron-rich, tasty dish during summer; add some butter to make it even more delicious*





# Mung Amaranth Saag

## Ingredients:

Mung dhal	:	50 g
Amaranth	:	200 g
Onion	:	50 g
Tomato	:	50 g
Green chillies	:	2 to 4 fruits
Garlic	:	3 to 4 cloves
Ginger	:	1 tbsp (paste)
Cumin seeds	:	¼ tsp
Oil/ghee	:	20 g
Salt, to taste	:	

## Nutrient composition:

Energy	:	491 kcal
Protein	:	22 g
Calcium	:	511 mg
Iron	:	10.73 mg (bioavailability 11.24%)
Phosphorus	:	433 mg
β-carotene	:	16.89 mg (2815 µg RE)
Thiamine	:	0.44 mg
Riboflavin	:	0.79 mg
Niacin	:	3.89 mg
Ascorbic acid	:	92 mg

## Preparation:

Serves three

1. Clean and wash mung dhal and amaranth leaves.
2. Finely chop the amaranth leaves, garlic, and green chillies.
3. Pressure cook mung dhal with amaranth, garlic, chillies, ginger paste, salt, and water (1 cup) for 10 minutes.
4. Blend the saag into paste manually or by using electric blender.
5. Fry finely chopped onions in oil/ghee until golden brown.
6. Add cumin seeds and chopped/pureed tomatoes. Cook until tomatoes are done and the mixture leaves the sides of the pan.
7. Add saag to this mixture and cook for a few more minutes.

*A delicious way  
to enjoy fresh  
vegetables  
during summer*





# Mungbean Sprout Salad

## Ingredients:

Mungbean	:	100 g (250 g sprouts)
Tomato	:	50 g
Onion	:	50 g
Cucumber	:	100 g
Green chillies	:	2 to 3 fruits
Coriander leaves	:	10 g (1 tbsp)
Lemon juice	:	15 ml (1 tbsp)
Black pepper, to taste	:	
Salt, to taste	:	

## Nutrient composition:

Energy	:	433 kcal
Protein	:	28 g
Calcium	:	249 mg
Iron	:	6.32 mg
(bioavailability 10.66%)		
Phosphorus	:	427 mg
β-carotene	:	0.77 mg (130 µg RE)
Thiamine	:	0.70 mg
Riboflavin	:	0.52 mg
Niacin	:	2.82 mg
Ascorbic acid	:	125 mg

Serves three

## Preparation:

1. Soak mungbeans in water for 12 hours, then drain the water and tie the mungbeans in muslin cloth.
2. Sprinkle water on the cloth to keep it moist until sprouts appear (at least 24 hours in summer and 36 hours in winter).
3. Steam sprouts in the pressure cooker with ½ cup of water for 5 minutes.
4. Finely chop onion, green chillies, and coriander leaves. Dice tomatoes and cucumber.
5. Add sprouts to the vegetables and sprinkle lemon juice, salt, and pepper over the mixture. Toss well.



*A complete meal  
along with curd*







# Sprouted Mungbean Pulao

## Ingredients:

Mungbean	:	100 g (250 g sprouts)
Rice	:	200 g
Tomato	:	100 g
Onion	:	75 g
Oil/ghee	:	20 g
Cumin seeds	:	½ tsp
Salt, to taste	:	

## Nutrient composition:

Energy	:	1845 kcal
Protein	:	39 g
Calcium	:	222 mg
Iron	:	7.34 mg
(bioavailability 8.82%)	:	
Phosphorus	:	711 mg
β-carotene	:	0.59 mg (98 µg RE)
Thiamine	:	0.75 mg
Riboflavin	:	0.45 mg
Niacin	:	4.77 mg
Ascorbic acid	:	76 mg

Serves three

## Preparation:

1. Sauté the onions and cumin seeds in the oil/ghee.
2. Clean and wash rice.
3. Boil 2½ cups of water. Add rice and salt in water and cook in closed pan for 10 minutes.
4. Add mungbean sprouts, diced tomato, sautéed onions and cumin seeds to the half-cooked rice. Cook for another 5 minutes under low heat.



*Mint leaves and mung sprouts add refreshing flavors and more nutrition to this curd*



# Mung Sprout - Mint Raita

## Ingredients:

Mung sprouts	:	300 g
Curd	:	400 g
Mint leaves	:	30 g
Green chillies	:	2 to 3 fruits
Cumin seed powder	:	½ tsp
Black pepper	:	¼ tsp
Salt, to taste	:	

## Nutrient composition:

Energy	:	602 kcal
Protein	:	39 g
Calcium	:	794 mg
Iron	:	10.51 mg
(bioavailability 7.18%)	:	
Phosphorus	:	737 mg
β-carotene	:	1.64 mg (273 µg RE)
Thiamine	:	0.78 mg
Riboflavin	:	1.18 mg
Niacin	:	2.78 mg
Ascorbic acid	:	66 mg

Serves three

## Preparation:

1. Make curd by adding the culture of *Lactobacillus* species to lukewarm milk and keeping it undisturbed for 6–8 hours for curdling.
2. Churn the curd into smooth consistency by adding a little water or milk in it.
3. Wash, clean, and chop the mint leaves and green chillies.
4. Roast cumin seeds and grind them.
5. Mix the steamed sprouts, mint leaves, chillies, cumin powder, and black pepper in the curd. Add salt to taste.



*Fermented mung balls in curd is a delicious, cool and savory dish*





# Dahi Bhalla

## Ingredients:

Mung dhal	:	100 g
Curd	:	400 g
Onion	:	50 g
Tomato	:	50 g
Coriander leaves	:	10 g (1 tbsp)
Cumin seeds	:	½ tsp
Oil/ghee, for frying		
Red chillies, to taste		
Salt, to taste		

## Nutrient composition:

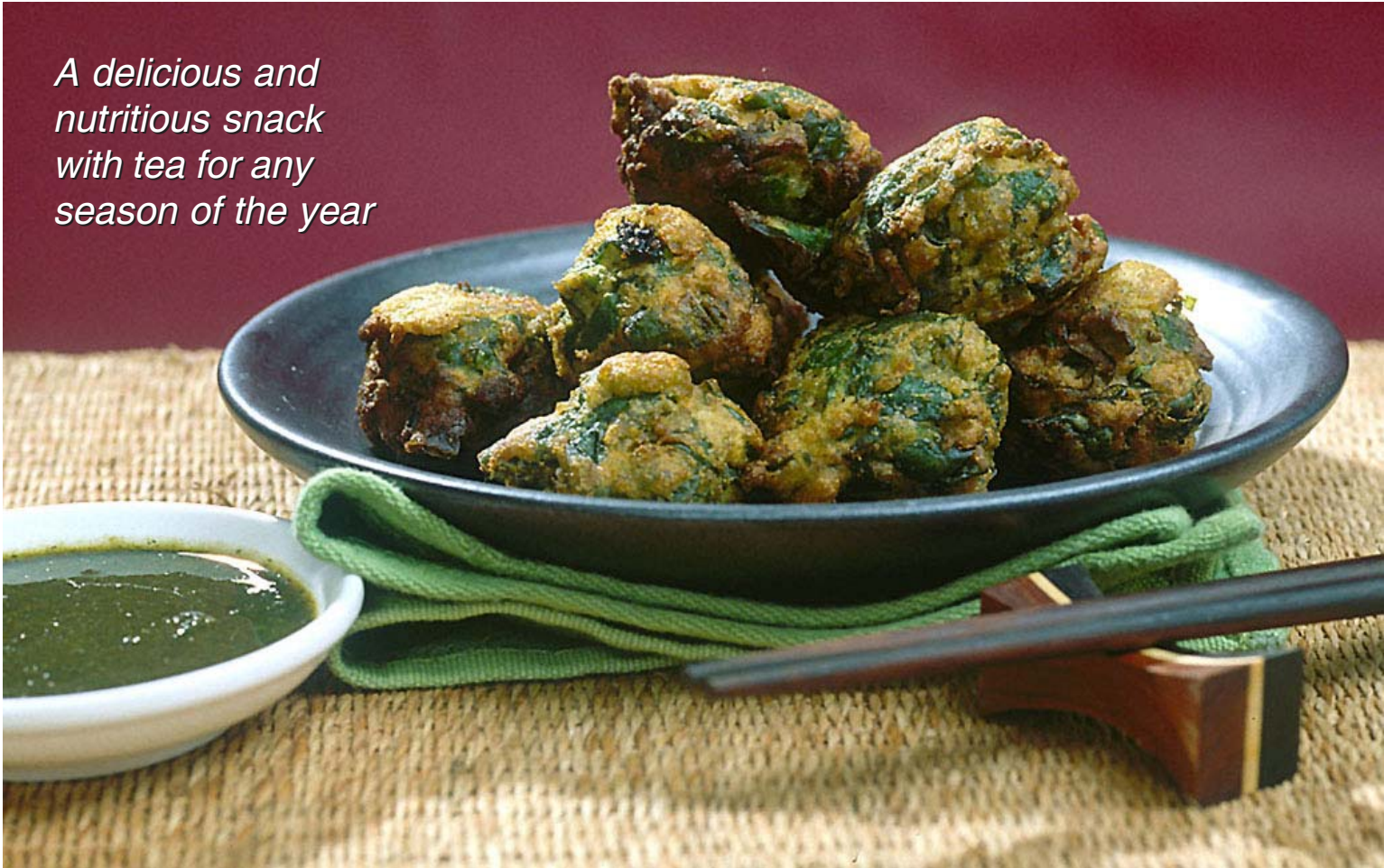
Energy	:	707 kcal
Protein	:	38 g
Calcium	:	782 mg
Iron	:	6.26 mg
(bioavailability 9.55%)		
Phosphorus	:	745 mg
β-carotene	:	0.77 mg (128 µg RE)
Thiamine	:	0.86 mg
Riboflavin	:	0.95 mg
Niacin	:	2.93 mg
Ascorbic acid	:	37 mg

## Preparation:

Serves three

1. Soak mung dhal overnight (6–8 hours) in water.
2. Grind dhal in electric blender or with pestle and mortar into a fine but thick paste. Ferment for 6–8 hours.
3. Add a pinch of salt in the paste, form into balls, and deep fry until the bhallas turn golden brown.
4. Soak bhallas in lukewarm water for one hour.
5. Churn the curd into fine consistency by adding a small amount of water or milk to it.
6. Add finely chopped onion, tomato, coriander leaves, salt, red chillies, and powdered cumin seeds to the curd.
7. Squeeze water from bhallas by pressing them softly between the palms of the hands.
8. Add bhallas to the curd and keep refrigerated until time of serving.


*A delicious and nutritious snack with tea for any season of the year*





# Mung Spinach Pakoda

## Ingredients:



Mung dhal	:	100 g
Spinach	:	100 g
Tamarind chutney	:	4 tbsp
Mint chutney	:	4 tbsp
Oil/ghee, for frying		
Salt, to taste		
Red chillies, to taste		
Garam masala, to taste		

## Nutrient composition:

Energy	:	651 kcal
Protein	:	28 g
Calcium	:	270 mg
Iron	:	12.06 mg
(bioavailability 9.73%)		
Phosphorus	:	391 mg
β-carotene	:	3.83 mg (638 µg RE)
Thiamine	:	0.58 mg
Riboflavin	:	0.52 mg
Niacin	:	2.69 mg
Ascorbic acid	:	34 mg

Serves three

## Preparation:

1. Soak mung dhal overnight (6–8 hours) in water.
2. Grind the soaked dhal in electric blender or with pestle and mortar into a fine paste.
3. Clean and chop spinach leaves.
4. Add spinach, salt, red chillies, and garam masala to the dhal paste.
5. Make balls using above mixture and deep fry in oil/ghee.
6. Serve hot with tamarind and mint chutneys.

*A nutritious snack  
liked by everyone, but  
especially by children*







# Mung Namkeen

## Ingredients:

Mung dhal	:	100 g
Onion	:	50 g
Tomato	:	50 g
Coriander leaves	:	10 g (1 tbsp)
Green chillies	:	2 to 3 fruits
Oil/Ghee	:	20 g
Lemon juice	:	15 ml (1 tbsp)
Salt, to taste	:	

## Nutrient composition:

Energy	:	608 kcal
Protein	:	26 g
Calcium	:	193 mg
Iron	:	5.49 mg
(bioavailability 10.42%)	:	
Phosphorus	:	374 mg
β-carotene	:	0.77 mg (128 µg RE)
Thiamine	:	0.67 mg
Riboflavin	:	0.31 mg
Niacin	:	2.54 mg
Ascorbic acid	:	37 mg

Serves three

## Preparation:

1. Soak mung dhal overnight (6–8 hours) in water.
2. Drain water and spread dhal on absorbent paper for 30 minutes.
3. Heat the oil/ghee and fry dhal under low heat until crisp. Add salt.
4. Rub dhal on absorbent paper to remove excess oil.
5. Cool and store in an airtight container to maintain crispness.
6. Serve with finely chopped onion, coriander leaves, and diced tomatoes. Sprinkle lemon juice over the mixture and toss well.


*A wholesome meal  
for breakfast or a  
delicious snack  
with tea*





# Poha

## Ingredients:



Mungbean	:	50 g (125 g sprouts)
Rice flakes	:	100 g
Cabbage	:	100 g
Onion	:	50 g
Potato	:	50 g
Coriander leaves	:	10 g (1 tbsp)
Oil/ghee	:	20 g
Tamarind chutney	:	50 g
Turmeric powder	:	1 tsp
Mustard seeds	:	1 tsp
Salt, to taste	:	
Red chillies, to taste	:	

## Nutrient composition:

Energy	:	859 kcal
Protein	:	23 g
Calcium	:	198 mg
Iron	:	8.08 mg
(bioavailability 10.70%)	:	
Phosphorus	:	524 mg
β-carotene	:	0.77 mg (128 µg RE)
Thiamine	:	0.64 mg
Riboflavin	:	0.34 mg
Niacin	:	6.47 mg
Ascorbic acid	:	171 mg

Serves three

## Preparation:

1. Put rice flakes in a sieve and wash under tap water.
2. Boil potatoes and cut into small pieces.
3. Chop cabbage, onions, and coriander leaves.
4. Fry onion in oil/ghee until golden brown.
5. Add potatoes, cabbage, steamed mung sprouts, chopped coriander leaves, turmeric powder, mustard seeds, red chillies, and salt. Cook for 2–3 minutes.
6. Add tamarind chutney and mix well.



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## Appendix I: U.S. Recommendations for Nutrient Intakes



Recommended Dietary Allowances (1989)														Dietary Reference Intakes 1997, 1998															
Age (yr)	Weight		Height		Protein (g)	Vit A (RE <sup>1</sup> )	Vit E (mg αTE <sup>1</sup> )	Vit K (μg)	Vit C (mg)	Iodine (μg)	Iron (mg)	Selenium (μg)	Zinc (mg)	Age (yr)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg NE)	Vit B6 (mg)	Folate (FE)	Vit B12 (μg)	Vit D (μg)	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Fluoride (mg)	Pantothenic (mg)	Biotin (μg)	Choline (mg)	
	(kg)	(lb)	(cm)	(in)																									
<b>Infants</b>														<b>Infants</b>															
0.0-0.5	6	13	60	24	13	375	3	5	30	40	6	10	5	0.0-0.5	0.2	0.3	2	0.1	65	0.4	5	210	100	30	0.01	1.7	5	125	
0.5-1.0	9	20	71	28	14	375	4	10	35	50	10	15	5	0.5-1.0	0.3	0.4	3	0.3	80	0.5	5	270	275	75	0.5	1.8	6	150	
<b>Children</b>														<b>Children</b>															
1-3	13	29	90	35	16	400	6	15	40	70	10	20	10	1-3	0.5	0.5	6	0.5	150	0.9	5	500	460	80	0.7	2	8	200	
4-6	20	44	112	44	24	500	7	20	45	90	10	20	10	4-8	0.6	0.6	8	0.6	200	1.2	5	800	500	130	1.1	3	12	250	
7-10	28	62	132	52	28	700	7	30	45	120	10	30	10																
<b>Males</b>														<b>Males</b>															
11-14	45	99	157	62	45	1000	10	45	50	150	12	40	15	9-13	0.9	0.9	12	1.0	300	1.8	5	1300	1250	240	2.0	4	20	375	
15-18	66	145	176	69	59	1000	10	65	60	150	12	50	15	14-18	1.2	1.3	16	1.3	400	2.4	5	1300	1250	410	3.2	5	25	550	
19-24	72	160	177	70	58	1000	10	70	60	150	10	70	15	19-30	1.2	1.3	16	1.3	400	2.4	5	1000	700	400	3.8	5	30	550	
25-50	79	174	176	70	63	1000	10	80	60	150	10	70	15	31-50	1.2	1.3	16	1.3	400	2.4	5	1000	700	420	3.8	5	30	550	
51+	77	170	173	68	63	1000	10	80	60	150	10	70	15	51-70	1.2	1.3	16	1.7	400	2.4	10	1200	700	420	3.8	5	30	550	
														>70	1.2	1.3	16	1.7	400	2.4	15	1200	700	420	3.8	5	30	550	
<b>Females</b>														<b>Females</b>															
11-14	46	101	157	62	46	800	8	45	50	150	15	45	12	9-13	0.9	0.9	12	1.0	300	1.8	5	1300	1250	240	2.0	4	20	375	
15-18	55	120	163	64	44	800	8	55	60	150	15	50	12	14-18	1.1	1.0	14	1.2	400	2.4	5	1300	1250	360	2.9	5	25	400	
19-24	58	128	165	65	46	800	8	60	60	150	15	55	12	19-30	1.1	1.1	14	1.3	400	2.4	5	1000	700	310	3.1	5	30	425	
25-50	63	138	163	64	50	800	8	65	60	150	15	55	12	31-50	1.1	1.1	14	1.3	400	2.4	5	1000	700	320	3.1	5	30	425	
51+	65	143	160	63	50	800	8	65	60	150	15	55	12	51-70	1.1	1.1	14	1.5	400	2.4	10	1200	700	320	3.1	5	30	425	
														>70	1.1	1.1	14	1.5	400	2.4	15	1200	700	320	3.1	5	30	425	
<b>Pregnant</b>														<b>Pregnant</b>															
					60	800	10	65	70	175	30	65	15		1.4	1.4	18	1.9	600	2.6	nc <sup>1</sup>	nc	nc	+40	nc	6	30	450	
<b>Breastfeeding/Lactating</b>														<b>Breastfeeding/Lactating</b>															
1 <sup>st</sup> 6 mo.					65	1300	12	65	95	200	15	75	19		1.5	1.6	1.7	2.0	500	2.8	nc	nc	nc	nc	nc	7	35	550	
2 <sup>nd</sup> 6 mo.					62	1200	11	65	90	200	15	75	16																

<sup>1</sup>RE = μg retinol equivalent; αTE = α-tocopherol; nc = no change

Source: National Academy of Sciences (1989, 1997, 1998)

## Appendix II: Conversion Factors for Measures

### SPOONS

	Metric Exact Conversion	Metric Standard Measure
1/4 teaspoon (tsp)	1.2 milliliter (ml)	1 ml
1/2 tsp	2.4 ml	2 ml
1 tsp	4.7 ml	5 ml
2 tsp	9.4 ml	10 ml
1 tablespoon (tbsp)	14.2 ml	15 ml

### CUPS

1/4 cup (4 tbsp)	56.8 ml	50 ml
1/3 cup (5 1/3 tbsp)	75.6 ml	75 ml
1/2 cup (8 tbsp)	113.7 ml	125 ml
2/3 cup (10 2/3 tbsp)	151.2 ml	150 ml
3/4 cup (12 tbsp)	170.5 ml	175 ml
1 cup (16 tbsp)	227.3 ml	250 ml
4 1/2 cups	1022.9 ml	1000 ml (1 L)

### DRY MEASUREMENTS

1 ounces (oz)	28.3 grams (g)	30 g
2 oz	56.7 g	55 g
3 oz	85.0 g	85 g
4 oz	113.4 g	125 g
5 oz	141.7 g	140 g
6 oz	170.1 g	170 g
7 oz	198.4 g	200 g
8 oz	226.8 g	250 g
16 oz	453.6 g	500 g
32 oz	907.2 g	1000 g (1 kg)

