



IIMR Profile

The Indian Institute of Millets Research (IIMR) formerly Directorate of Sorghum Research (DSR) and National Research Centre for Sorghum (NRCS), is the central agency to work on all aspects of millet/sorghum research and development under the auspicious of Indian Council of Agricultural Research (ICAR). While the main centre at Hyderabad campus is principally engaged in both basic and strategic research on sorghum, region-specific research and services are organized through two other centres - Solapur and Jalna in Maharashtra. It was earlier a multi-crop centre, and its pioneering work in hybrid and varietal development has created indelible impact with its contributions in developing superior varieties of groundnut, red-gram and castor in addition to millet/sorghum hybrids and varieties. Millets being mainly a rainfed crop, is grown with limited inputs. There-fore, varietal improvement leading to high yielding hybrids and varieties forms the core of major research achievements. Its impact can be best illustrated by the fact that even rupee spent by the government, the national income increase by 40-fold. Through its network centres located across the country in various geographical zones, 26 hybrids (CSH 1 to CSH26) and 26 varieties.

ISBN81-89335-62-6

– A Healthy Choice

MILLET RECIPES

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– A Healthy Choice



ICAR-Indian Institute of Millets Research
Rajendranagar, Hyderabad – 500 030, Telangana, India



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Millet Recipes - A Healthy Choice



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Printed on : June 2016

Citation : Dayakar Rao B, Vishala AD, Arlene Christina GD, Tonapi VA, 2016
Millet Recipes, A Healthy Choice, ICAR- Indian Institute of
Millets Research, Rajendranagar, Hyderabad, pp 138

ISBN : ISBN81-89335-62-6

Copyright : ICAR- Indian Institute of Millets Research, Hyderabad

Disclaimer : @ Indian Council of Agricultural Research

Published by : Director,
ICAR- Indian Institute of Millets Research
Rajendranagar, Hyderabad - 500 030. India.
www.millets.res.in

Printed at : XXXXXXXXXXXXXXXX

Designed by : CREA Branding Solutions - 99896 96481

ACKNOWLEDGMENTS

The authors are grateful to IIMR for their financial support in bringing out this publication. Thanks to PJTSAU (erstwhile ANGRAU) for undertaking nutrient analysis under the NAIP project. The authors acknowledge the technical support of project staff under NFSM project, Kavitha C., G. Sudha Devi, E. Kiranmai, B. Ramesh Babu and Y. Latika Devi for their assistance. The other contributors including Mr. H.S. Gawali, photographer, IIMR who helped in bringing out this book are acknowledged.



Dr. T. Mohapatra
Secretary DARE & Director General,
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FOREWORD

Millets are a traditional staple food of the dry land regions of the world. They are nutri-cereals which are highly nutritious and are known to have high nutrient content which includes protein, essential fatty acids, dietary fibre, B-Vitamins and minerals such as calcium, iron, zinc, potassium and magnesium. They help in rendering health benefits like reduction in blood sugar level (diabetes), blood pressure regulation, thyroid, cardiovascular and celiac diseases. However, the direct consumption of millets as food has significantly declined over the past three decades. The major reasons of decrease in consumption is the lack of awareness of nutritional merits, inconveniences in food preparation, lack of processing technologies and also the government policy of disincentives towards millets and favoring of supply of fine cereals at subsidized prices. Hence developing technology that makes millet value added products available as convenient to make and easy access at reasonable prices will find great demand and market particularly in urban places where there is growing conscious for nutritive intake of food. As a step towards this, under the NAIP project, Indian Institute of Millets Research (IIMR) has taken up the millet processing, and developed value added sorghum/millet products.

The recipe book “Millet Recipes - A Healthy Choice” developed by IIMR is a compilation of such ready to cook and ready to eat foods for the benefit of urban population in particular. All the products are nutritionally rich and proved to be benefit for all age groups. This book on a whole provides information on millet value added products, their method of preparation and health contents to benefit the consumers and also small and medium entrepreneurs.

I congratulate IIMR in bringing out this publication for creation of demand for millets. I, also congratulate Dr. B. Dayakar Rao and his team for his extraordinary efforts to bring this publication in useful manner. This book is expected to serve as one stop solution for millet based products, their recipes and nutritional parameters for households, entrepreneurs and other stake holders alike.

(T. Mohapatra)



Dr. Vilas .A Tonapi
Director ICAR - IIMR

PREFACE

Millets are important crops for dryland farmers; they are highly nutritious and are climate-compliant crops. But overall millet consumption in India has declined over the years. In order to revive the demand of millets in India, the IIMR has made attempts to innovate technologies that enable in developing sorghum/millet based value added products through NAIP sub project, 'Creation of Demand through PCS Millets Value Chain'.

In this present era, consumers prefer high-quality foods with longer shelf life. They also look for products which are convenient to prepare as people are too busy in their daily schedule. Moreover, people have increased their tendency to eat a greater variety of foods both traditional and conventional. Efforts are being made to create awareness on the potential health benefits of millets which are recommended for obese, diabetic, celiac and other lifestyle diseases. In order to make millet value chain sustainable, the production and promotion of various products in the market is very much essential. Under this motto, IIMR launched its brand name "Eatrite" to the Indian markets to promote the millet based products and this book gives details of these products.

This book comprehensively deals with the millet based ready to cook products, methods of recipe preparation and nutritive value of the respective products. Most of compilation of nutritional studies is of the successful sorghum value chain interventions under the NAIP sub project. This publication, hopefully would be used by households and food entrepreneurs as it includes both traditional and non- traditional food items that can replace regular rice and wheat recipes. Particularly in urban areas where there is considerable demand for nutrient rich and ready to cook foods, this publication may be valuable. I, congratulate Dr. B. Dayakar Rao and his team for his extraordinary efforts to bring this book and appreciate the efforts they have put in the process.

Tonapi VA
Director, ICAR - IIMR

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INTRODUCTION

Millets – The Tradition of India



We've all heard the old saying “You are what you eat”, and it's still true. A balanced nutritive diet is the *mantra* to good health. In recent times people are becoming conscious of the consumption of balanced and nutritional diet leading to a healthy lifestyle. Millet grains have been the traditional component of food basket in India. So why not include it in the daily diet, eat right (*eatrite*) and stay healthy !

Millets are nutri cereals comprising of sorghum, pearl millet, finger millet (major millets) foxtail, little, kodo, proso and barnyard millet (minor millets). These are one of the oldest foods known to humanity. These are one of the several species of coarse cereal grasses in the family *Poaceae*, cultivated for their small edible seeds. They are highly nutritious, non-glutinous and not acid forming foods. Hence they are soothing and easy to digest.

They contain high amounts of dietary fibre, B-complex vitamins, essential amino and fatty acids and vitamin E. They are particularly high in minerals, iron, magnesium, phosphorous, potassium and release lesser percentage of glucose over a longer period of time causing satiety which lowers the risk of diabetes. These grains are high in carbohydrates, with protein content varying from 6 to 11 percent and fat varying from 1.5 to 5 percent.

Millets are typically annuals and range in height from 30 to 130 cm with the exception of sorghum and pearl millet, which has stalks 1.5 to 3 m tall and about 2.5 cm thick. The inflorescences may be spikes or racemes, in which the flowers are borne on stalks of about equal length along an elongated axis, or panicles with dense clusters of small florets. With the exception of pearl millet, seeds remain enclosed in hulls after threshing. Hulled seeds are usually creamy white.

In India, millets has been a staple diet and a main source of income for farmers especially in the semi-arid regions. They are important food and fodder crop in the semi-arid tropics (SAT) of the world and grows in both *kharif* and *rabi* seasons. These grains represent the major source of dietary energy and protein for more than a billion people in the semi-arid tropics.





RECIPES FROM SORGHUM

SORGHUM

Scientific name: *Sorghum bicolor* (L.) Moench.

Hindi name: *Jowar*; Telugu name: *Jonnalu*

Sorghum is traditional staple food of the dry land regions of the world, a warm season crop intolerant to low temperatures, resistant to pests and diseases highly nutritious and a climate-compliant crop.

It ranks fifth in cereals produced world-wide and fourth in India. Generally, sorghum grains act as a principal source of protein, vitamins, energy and minerals for millions of people especially in the semi-arid regions playing a crucial role in the world's food economy. It has a nutritional profile better than rice which is the staple food of majority of the human population for its rich protein, fibre thiamine, riboflavin, folic acid, calcium, phosphorous, iron and β -carotene.

Sorghum is rich in potassium, phosphorus and calcium with sufficient amounts of iron, zinc and sodium. Due to this, it is being targeted as a means to reduce malnutrition globally. It helps to control heart problems, obesity and arthritis.



Sorghum Annam

Ingredients:

Dehulled sorghum grain - 1 cup

Preparation Method:

- Cook pearled or dehulled sorghum in the boiling water till the grains become smooth and palatable.
- It can also be prepared in pressure cooker for 5-10 minutes.

Sorghum Dosa

Ingredients:

Sorghum grain - 3 cup, black gram *dal* - 1 cup, salt and oil (for shallow fry)

Preparation Method:

- Grind the soaked sorghum grain and black gram *dal* together into a fine batter. Add salt for taste and allow it for fermentation.
- Apply a tea spoon of oil on the pre-heated *dosa* making *tawa* and pour the batter on it, spread with scoop into thin round shape. Fry till crisp *dosa* is obtained.
- Serve hot with *chutney*.





Sorghum Ambali

Ingredients: Sorghum flour - 1/2 cup, rice starch soup and salt as required.

Preparation Method:

- Mix sorghum flour with luke warm water carefully to avoid formation of lumps.
- Add rice starch soup & salt to the above mixture and cook for 15-20 min
- Cool the drink, or else ferment for overnight in earthen pot and can be consumed next day.

Sorghum Roti

Ingredients: Sorghum flour - 100 g

Preparation Method:

- Add hot water to the sieved sorghum flour. Knead into smooth soft dough. Make round ball (approx 50 g) and spread it into round shape on polythene sheet by using a rolling stick or by pressing with the palm.
- Bake the *roti* properly on both the sides of a pre heated *tawa*.
- Serve hot with any curry or *dal*.





Sorghum Vegetable Tawa Roti

Ingredients:

Sorghum flour – 25 g, chopped onions, capsicum, carrot, cabbage, green chilli paste, sesame seeds, jeera, salt – as desired and water – as required.

Preparation Method:

- Mix the ingredients thoroughly by adding required amount of water to make it like *chapati* dough.
- Make small balls and spread it into round using roller stick and roast it in pre-heated *tawa* on both sides.

Sorghum Samosa

Ingredients:

Sorghum flour – 1 cup, *maida* – 1 cup, potatoes – 1 cup, boiled peas, onions, green chillies and curry leaves as required.

Preparation Method:

- Take one cup of sorghum flour and one cup of *maida*. Mix well and add required amount of water to make dough.
- Make small *chapati* balls and spread the dough with roller stick and cut into half's.
- Mash boiled potatoes, add chopped onions, green chillies and curry leaves.
- Make seasoning with chopped onions, green chillies, curry leaves and boiled mashed potatoes, boiled peas and salt to taste.
- Fill the above mixture in each half and fold in triangular shape and deep fry.
- Serve hot with tomato sauce or *chutney*.





Sorghum Upma

Ingredients:

Sorghum *rawa* – 1 cup; bengal gram dal, mustard seeds; Chopped onion, green chillies, carrot, tomato and curry leaves – as required.

Preparation Method:

- Roast 1 cup sorghum *rawa* till it turns brown.
- Season the in another pan mustard seeds, bengal gram *dal*, onion, green chillies, carrot, tomato and curry leaves.
- Add 3 cups water, salt and boil. Add roasted *rawa* slowly.
- Cook well till it become soft at low flame and serve hot.

Sorghum Sankati

Ingredients:

Sorghum *rawa* – 1 cup, sorghum flour – 1 cup, cooked rice – ¼ cup and salt – for taste.

Preparation Method:

- Add sieved sorghum *rawa* to the boiled water.
- Cook at low flame for 5 min, then add sorghum flour slowly & mix thoroughly so that lumps are not formed.
- After 10 min of cooking, add some cooked rice and mix well and again cook for 15-20 min.
- Make that mixture into small balls
- Serve hot with vegetable curry or *chutney*





Sorghum Kesari

Ingredients:

Sorghum *rawa* – 1 cup, dry fruits (cashew, *pista*, *badam* and rasins) – ¼ cup, ghee – 1 tsp and milk – ½ cup.

Preparation Method:

- Roast sorghum *rawa* and dry fruits separately in little oil/ghee to light brown.
- In a pan boil milk with a pinch of *kesari*.
- Add fried *rawa* and sugar to the boiled milk and allow it for cooking for 15 minutes.
- Garnish it with dry fruits, and little ghee before serving hot.

Sorghum Khichidi

Ingredients:

Sorghum *khichidi rawa* – 1 cup, *moong dal* – ½ cup; mustard seeds, chopped onions, green chillies, tomato, curry leaves, ginger garlic paste, turmeric powder, salt and water – as required.

Preparation Method:

- Soak green *moong dal* and sorghum *rawa* for 15 min.
- Season with mustard seeds, onion, green chillies, ginger garlic paste, tomatoes, curry leaves and turmeric powder.
- Add sufficient water and salt, cook at low flame till it is cooked properly and serve hot.



Sorghum Chuduwa

Ingredients:

Sorghum flakes - 1 cup, blackgram *dal*, fried *channa dal*, *jeera*, ground nuts, red chillies – as required; oil – for deep frying.

Preparation Method:

- Fry the flakes in oil and keep separately
- Heat the oil and add black gram *dal*, fried *channa dal*, *jeera*, groundnuts, red chillies and fry till it turns brown, then add chopped onions, green chilli paste and pinch of turmeric powder.
- Now add salt to taste then fry all these ingredients together.
- Add fried flakes to the above ingredients and mix thoroughly.

Sorghum Idli

Ingredients:

Sorghum *idli rawa* - 3 cups and black gram *dal* - 1 cup

Preparation Method:

- Make batter with soaked (overnight) black gram *dal*.
- Mix washed sorghum fine semolina to the batter, add salt to taste and allow it for fermentation.
- Pour the batter in to greased stainless steel *idli* molds and steam for 15-20 min.
- Serve hot with *chutney*





Sorghum Pongal

Ingredients:

Sorghum flakes – ½ cup, moong dal – ½ cup, salt, ground pepper, cumin, cashew, curry leaves – as required.

Preparation Method:

- Cook ½ cup moong dal till it becomes soft.
- Add ½ cup flakes, 2 cups of milk and cook till it turns very soft.
- Add salt and season with ground pepper, cumin, cashew nut, curry leaves and serve hot.

Sorghum Pongal (sweet)

Ingredients:

Sorghum flakes – ½ cup, moong dal – ½ cup, milk – 2 cups, jaggery – 1 cup, cardamom powder, ghee, cashew nuts, dry coconut – as required.

Preparation Method:

- Cook ½ cup moong dal till it becomes soft.
- Add ½ cup flakes, 2 cups of milk and cook till it turns very soft.
- Add 1 cup jaggery and cardamom powder. Heat ghee, fry cashew nuts, dry coconut and add to sweet pongal and serve hot.





Pure Sorghum Biscuit

Ingredients:

Sorghum flour, baking powder, fat, sugar, essence and salt.

Preparation Method:

- Mix sorghum flour, baking powder, salt and sieve it.
- Cream fat and sugar in planetary mixer for 30 min.
- Add sorghum flour and mix for 5 minutes.
- Place the dough in a cookie cutter to cut into cookie shape.
- Bake it in an oven at 150°C for 30 min, cool and pack.

Sorghum Peda

Ingredients:

Sorghum flakes – 1 cup, powdered sugar – 3/4 cup; ghee, cashew and *badam* – as required.

Preparation Method:

- Roast the flakes and grind it to fine powder.
- Add equal quantity of sugar to flakes powder and mix well. Add ghee slowly to the flakes powder and make in to small balls.
- Decorate with cashew or *badam*.





Sorghum based salt biscuits

Ingredients:

Sorghum flour, baking powder, fat, sugar, essence and salt.

Preparation Method:

- Creaming of fat and sugar is done in planetary mixer for 30 min.
- Then add flour and other ingredients to the creamed mixture
- Make the mixture in to soft dough.
- Roll the dough and cut it into moulds.
- Bake the moulds at 150° C for 15-20 minutes.
- Then cool them for some time and pack.

Sorghum based sweet biscuits

Ingredients:

Dehulled sorghum flour, refined wheat flour, skimmed milk powder, baking powder, fat, sugar, vanilla essence and salt.

Preparation Method:

- Creaming of fat and sugar is done in planetary mixer for 30 min.
- Then add flour and other ingredients to the creamed mixture.
- Make the mixture in to soft dough.
- Roll the dough and cut it into moulds.
- Bake the moulds at 150° C for 15-20 mins.
- Then cool them for some time and pack.





Sorghum based groundnut biscuits

Ingredients:

Dehulled sorghum flour, refined wheat flour, skimmed milk powder, salt, ammonia, roasted groundnut grits, egg, baking powder, fat, sugar, vanilla essence and salt.

Preparation Method:

- Creaming of fat and sugar is done in planetary mixer for 30 min.
- Then add flour, half of the groundnut grits and other ingredients to the creamed mixture.
- Make the mixture in to soft dough.
- Roll the dough.
- Sprinkle rest of the groundnut powder on the rolled sheet.
- Now cut the dough into moulds.
- Bake the moulds at 150° F for 15-20 min and cool them.
- Then cool for some time and pack.

Sorghum based coconut biscuits

Ingredients:

Dehulled sorghum flour, refined wheat flour, skimmed milk powder, salt, ammonia, desiccated coconut, egg, baking powder, fat, sugar, vanilla essence and salt.

Preparation Method:

- Creaming of fat and sugar is done in planetary mixer for 30 min.
- Then add flour, half of the desiccated coconut and other ingredients to the creamed mixture.
- Make the mixture in to a soft dough.
- Roll the dough.
- Sprinkle rest of the coconut powder on the rolled sheet.
- Now cut the dough into moulds.
- Bake the moulds at 150° F for 15-20 minutes.
- Then cool for some time and pack.





Sorghum Vermicelli Kheer

Ingredients:

Sorghum vermicelli – ½ cup, sugar – 1/4 cup, milk – ½ cup

Preparation Method:

- Fry the vermicelli, cashew nuts and other dry fruits with fat
- Boil the water and milk, then add roasted vermicelli. After it is half cooked, add sugar and stir slowly for 10-15 minutes until it is cooked.
- Add cardamom powder and decorate with cashew nuts and other dry fruits.
- Serve hot as a traditional sweet

Sorghum Vermicelli Upma

Ingredients:

Sorghum vermicelli – ½ cup, mustard seeds, *channa dal*, black gram *dal*, cumin, ground nuts, curry leaves and salt as required

Preparation Method:

- Roast the sorghum vermicelli in little oil
- Make seasoning with mustard seeds, *channa dal*, *backgram dal*, cumin, ground nuts and curry leaves
- Pour water and boil, add salt to taste
- Cook vermicelli in above boiled water and serve hot.





Sorghum Cabbage Muthias

Ingredients:

Grated cabbage-1 cup, sorghum flour -1 cup, curd, chopped coriander, lemon juice, ginger-green chilli paste, grated garlic, turmeric powder, baking soda, sugar and salt - as required.

Preparation Method:

- Combine all the ingredients in a bowl and knead to make a soft dough using enough water.
- Divide the dough into a 3 equal parts and shape each portion into a cylindrical roll.
- Place the rolls on a greased steaming dish and steam for 10 to 12 min. till firm.
- Remove, cool and cut into thick slices and saute over a low flame till they are lightly browned.
- Serve hot, garnished with coriander.

Sorghum Pancake

Ingredients:

Sorghum flour-2 cups, non-fat dry milk powder - 1/2 cup, baking powder, sugar, salt, , eggs, oil and water – as required.

Preparation Method:

- Combine dry ingredients in a bowl.
- Stir in eggs, oil and water in another bowl.
- Mix both the mixtures well.
- Drop by spoonfuls onto a hot, griddle and cook until golden brown, turning once.
- Note: If you like thinner pancakes add more water or add some applesauce.





Sorghum based Sharbat

Ingredients:

Sorghum flour - 1 cup , barley 1/2 cup, sugar, pepper corns, lemon and water – as required.

Preparation Method:

- Add sorghum flour and barley to cold water and boil in simmer for 20 minutes.
- Remove the pan from the heat and add the peppercorns, lemon zest and sweetener.
- Stir, cover, and cool to room temperature and chill well.
- Before serving, blend in the lemon or pour over ice and garnish with a citrus twist.

Sorghum Gorimetteelu

Ingredients:

Sorghum flour - 1 cup, maida - 1 cup, chilli powder and oil - as required.

Preparation Method:

- Prepare dough with sorghum flour and maida. Add small quantity of hot oil while dough making
- Roll the *roti* from the dough
- Make shapes manually and press in between with fingers
- Fry the prepared *gorimettalu* in oil
- Excess oil is to be drained using tissue paper before serving





Sorghum Jeera/Sweet Lassi

Ingredients:

Germinated sorghum flour – 5 g, milk – 100 ml, curd – 2 ml, sugar – as desired; cumin powder (*jeera*), salt – as desired.

Preparation Method:

- Boil milk and cool it till lukewarm
- Add 5 g of germinated sorghum powder and heat up and hold for 10 min.
- Add curd culture to it and allow it to become curd.
- Keep the curd in refrigerated conditions.
- To make *jeera lassi* add cumin powder, salt and stir continuously for 5-10 min to avoid the lumps, and then filter whole material and chill.
- To make sweet *lassi* add sugar and stir continuously for 5-10 min to avoid the lumps and chill. (If needed add rose syrup or *leechi* syrup)
- Best when served chilled.

Sorghum Eggless Cake

Ingredients:

Sorghum flour – 1 cup, condensed milk or powder – ½ cup, oil – 1 cup, baking powder – 1 g, powdered sugar – ¾ cup, baking soda – 1 g, curd – ½ cup and vanilla essence – 2 ml

Preparation Method:

- Preheat the oven to 180°C before mixing of ingredients.
- Mix curd, milk and oil well and add powdered sugar, baking powder, baking soda and mix well.
- Add essence and sorghum flour to the mixture.
- Grease the cake tray with oil and put the cake batter without air bubbles into it.
- Bake at 180°C for 30 min after which remove the cake from the mould and serve.





Sorghum Cake

Ingredients:

Sorghum flour - 100 g, vanilla essence - 3 ml, fat - 100 g, baking powder - 3 g, egg - 2, cocoa powder - 5 g, sugar - 100 g, salt - 2 g and milk - 20 ml

Preparation Method:

- Pre heat oven to 180°C, sieve all dry ingredients thrice for uniform mixing.
- Sugar powder and egg whites are to be beaten well and add milk, essence and egg yolk and mix well.
- Add sorghum flour, salt, cocoa powder and baking powder and make into fine batter.
- Put the batter in baking bowl and place in the oven at 180°C for 25-30 min.
- Take the cake out and wait for 10 min until it cools.
- The cake is removed from mould, cut into pieces and serve

Sorghum Bhakarwadi

Ingredients: (*Masala*): Pepper - 10 g, sugar - 40 g, sesame - 50g, aniseed - 8 g, cumin - 25 g, almond - 10g, coriander - 50 g, - 15 g, salt - 15 g, chilli powder - 30g, poppy seed powder - 10g, *chat masala* - 8 g; (*Dough*) blackgram *dal* - 50 g; sorghum flour - 50 g, bengal gram flour - 50 g, wheat flour - 60 g, oil - for frying and water - as required.

Preparation Method:

- Prepare *masala* for *bhakarwadi*.
- Mix all the flours with water and add oil and knead till dough consistency and make small balls.
- Roll the small balls into round shapes and put the *bhakarwadi masala* onto the round shape.
- Roll inward and cut the roll into small pieces.
- Fry the small rolls in oil until golden colour appears.
- This can be consumed as an evening snack.





Sorghum Halwa

Ingredients:

Sorghum Flour – 1 cup, jaggery – 1 cup, butter - 1 cup and milk - 1 cup

Preparation Method:

- In one pan roast sorghum flour and ghee until the aroma and color changes.
- Add milk to the mixture and cook
- Add the melted jaggery, ghee and mix well without formation of lumps till thick consistency.
- Pour the prepared batter in a mould and allow to set.

Sorghum Chandravankalu

(Moon biscuits)

Ingredients:

Sorghum flour – 1 cup, whole wheat flour – 1 cup, sugar powder – 1 cup, butter – 2 tsp and oil – 1/4 cup.

Preparation Method:

- Mix sorghum flour, whole wheat flour, powdered sugar and butter
- Add oil to the flour and make it into dough and roll it.
- Cut crescent shapes of dough pieces and place it onto a greased bakery tray.
- Bake it in oven at 150°C for 20 min for preparation of sorghum moon biscuits.
- Cool and pack.





Sorghum Spicy Boondi

Ingredients:

Sorghum flour- 60 g, bengal gram flour - 40 g, oil - for frying ; chilli powder, salt, curry leaves, fried cashew nut and water - as required

Preparation Method:

- Mix sorghum flour, bengal gram flour and water till batter consistency.
- Put the batter onto a *boondi* frame and fry the *boondi* till golden colour
- Excess oil is to be removed by placing the *boondi* on tissue.
- In a pan roast cashew and curry leaves in oil.
- Add appropriate amount of salt, chilli powder, roasted cashew nuts and curry leaves to make spicy sorghum *boondi*.

Sorghum Boondi Laddu

Ingredients:

Sorghum flour - 60 g, bengal gram flour - 40 g, oil - for frying; sugar - 50 g, rasins, cashew nut, cardamom powder, ghee and water - as required

Preparation Method:

- Mix sorghum flour, bengal gram flour and water till batter consistency.
- Put the batter onto a *boondi* frame and fry the till *boondi* golden colour.
- Take sugar and water in a pan, and boil till a single thread consistency and add the cardamom powder and mix well.
- Now take *boondi* is in a bowl, add in the sugar syrup.

Make lemon size balls and serve





Sorghum Uttapam

Ingredients:

Sorghum grain – 1 cup, blackgram *dal* – 1/4 cup, ginger-green chilli paste – 1/4 tsp, salt - to taste; oil - for greasing and cooking, chopped tomatoes and coriander – 1 tsp.

Preparation Method:

- Wash and soak the whole sorghum grain and blackgram *dal* in enough water separately overnight. Drain well.
- Combine the whole sorghum grain, blackgram *dal* and water in a mixer, blend till smooth and add ginger-green chilli paste and salt and mix well.
- Heat the pan and grease it using ½ tsp of oil.
- Pour small spoonfuls of the batter on the pan like *uttappam*.
- Sprinkle little tomatoes and coriander evenly over each *uttappam*, press lightly and cook on both the sides on a medium flame.
- Serve hot with pickle.

Sorghum Parboiled Wada

Ingredients:

Parboiled sorghum grain – 1 cup, bengal gram flour – 1/4 cup, oil – for frying, salt – for taste, clove – 1/4 tsp, chilli powder – 2 tsp, cinnamon – 1/4 tsp

Preparation Method:

- The parboiled sorghum grain is taken and made into a coarse paste in wet grinder or grinder.
- Bengal gram flour, salt, clove, chilli powder and cinnamon are added to the above mixture.
- Small balls of the mixture are made and made into *wada*.
- The *wada* is fried in oil.
- Excess oil is removed using tissue paper and served with tomato sauce or *chutney*.





Cream of Sorghum Soup

Ingredients:

Sorghum grain – 100 g, bouguetgarni – 1 no, roughly cut vegetables (leeks, celery, carrot, onion and turnip) – 100 g, veg. stock – 1000 ml and seasoning – to taste

Preparation Method:

- Clean and boil sorghum along with all the vegetables.
- Add a sprig of bouguetgarni.
- When all ingredients are well done remove bouguetgarni.
- Blend it in a mixer and bring back in a pan to re-boil.
- Adjust the seasoning and add a dash of fresh cream.
- Serve it piping hot with garlic bread.

Source: ICAR-CIAE, Bhopal





RECIPES FROM PEARL MILLET

PEARL MILLET

Scientific name: *Pennisetum glaucum* (L.) R. Br.

Hindi name: *Bajra*; Telugu name: *Sajjala*

Pearl millet plant was probably domesticated as a food crop some 4000 to 5000 years ago along the southern margins of the central highlands of the Sahara. It has since become widely distributed across the semiarid tropics of Africa and Asia.

Pearl millet has traditionally been an important grain, forage, and stover crop primarily in the arid and subtropical regions of many developing countries. Pearl millet is well adapted to growing areas characterized by drought, low soil fertility, and high temperature. Because of its tolerance to difficult growing conditions, it can be grown in areas where other cereal crops, such as maize or wheat, would not survive.

This millet possess phytochemicals that lower cholesterol. It also contains foliate, magnesium, copper, zinc and vitamins E and B-complex. It has high energy content compared to other millets. It is also rich in calcium and unsaturated fats which are good for health.





Pearl millet Onion *Muthias*

Ingredients:

Pearl millet - 1 cup, onions chopped, turmeric, chilli powder, coriander, cumin seeds, ginger-green chilli paste, baking soda, salt and oil – as required.

Preparation Method:

- Combine all ingredients and mix well and knead into a semi-soft dough.
- Apply a little oil and shape into cylindrical and cut into slices.
- Heat the remaining oil in a non-stick pan and add the mustard seeds.
- Shallow fry the pieces in oil and season with cumin seeds.
- Serve hot garnished with coriander.

Pearl Millet *Upma*

Ingredients:

Pearl millet *rawa* - 1 cup, chopped onions, green chillies, carrot, beans, potato ginger, mustard seeds, blackgram *dal*, bengal gram *dal*, curry leaves, water and oil – as required.

Preparation Method:

- Roast pearl millet *rawa* till it turns brown.
- Season with chopped onions, green chillies, veggies, finely blackgram *dal*, *chanadal*, curry leaves, mustard seeds, curry leaves and green chillies.
- Add carrots, beans, and potato saute for 2 to 3 minutes.
- Add water and add roasted *rawa* cook well till it becomes soft and serve hot





Pearl Millet *Roti*

Ingredients:

Pearl millet flour - 1 cup, water - as required

Preparation Method:

- Add hot water to the sieved pearl millet flour. Knead into smooth soft dough.
- Make round ball and spread it into round shape on polythene sheet by rolling stick or by hand pressing with palm.
- Bake the *roti* properly on both the sides of a pre heated *tawa*.
- Serve hot with any curry or *dal*.

Pearl Millet *Pakoda*

Ingredients:

Chopped onion, green chilli; pearl millet flour - 1 cup, bengal gram flour - 1/2 cup; chilli powder and salt - as required.

Preparation Method:

- Mix pearl millet sorghum flour, bengal gram flour, chopped onion, green chilli, chilli powder, salt and water with medium batter consistency.
- Fry the batter in oil with the required shapes.
- Excess oil is removed in a tissue.
- This is served as evening snack along with tomato sauce.





Pearl Millet *Halwa*

Ingredients:

Pearl millet flour- 1 cup, jaggery – 1 cup, butter - 1 cup and milk - 1 cup

Preparation Method:

- In one pan roast pearl millet flour in ghee until the aroma and color changes.
- Add milk to the mixture and cook
- Add the melted jaggery, ghee and mix well without formation of lumps till thick consistency.
- Pour the prepared batter in a mould and allow to set.

Pearl Millet *Pesarattu*

Ingredients:

Pearl millet -1 cup, whole green gram -1 cup, red chillies-4, green chillies – 2, chopped onion -2-3, ginger - 1/2 inch, salt to taste and coriander leaves chopped - 2 tsp

Preparation Method:

- Soak pearl millet and whole green gram together for 5-6 hr and grind them to batter consistency and ferment for 3-4 hr.
- Grind red chillies, green chillies, ginger, needed salt and add to the batter along with finely chopped onions and coriander leaves.
- Heat a *tawa* on medium flame and put *pesarattu*.
- Flip the *pesarattu* to the other side for cooking on both sides.
- Once cooked remove from *tawa* and serve hot with any *chutney/ sambar*.





Pearl Millet *Thalipeeth*

Ingredients:

Pearl millet flour - 1 cup, rice flour - 2 tsp, onions - 1 finely chopped, green chillies - 1 to 2 (optional), garlic paste - 1/2 tsp (optional), salt to taste, coriander - (2-3) tsp finely chopped, oil - for cooking, warm water - to knead and *ajwain* - 1/2 tsp

Preparation Method:

- Mix all ingredients by adding warm water and knead into a dough
- Make small (golf ball size) rounds of the dough and on plastic sheet apply some oil and press it into a flat circle and create hole in the center.
- The *thalipeeth* shouldnt be too thin, as it may break.
- Shallow fry in a pan.
- Remove on paper napkin, serve hot with *chutney*, sauce or pickles.

Pearl Millet *Khichidi*

Ingredients:

Pearl millet - 1 cup, *moong dal* - 1 cup, potato, carrot, beans, green peas, salt, oil, onion, green chillies, tomato, asafoetida, cumin seeds, mustard seeds, ginger garlic paste, red chili powder, coriander powder, turmeric powder, 2 tbsps - chopped coriander leaves, lemon juice - as required.

Preparation Method:

- Soak pearl millet grain and *moong dal* over night.
- Boil all the vegetables
- In a pressure cooker add soaked, washed pearl millet grain, *moong dal*, all the vegetables, green chilli, salt, turmeric powder and 4 cups water and cook for 3-4 whistles.
- In a pan saute onion, green chilli, asafoetida, cumin seeds and mustard seeds in oil.
- Add red chili powder, and mix cooked millet grain well, simmer for 2-3 mins, adjust salt if required.
- Season with coriander leaves and lemon juice and serve hot.





RECIPES FROM FINGER MILLET

FINGER MILLET

Scientific name: *Eleusine coracana* (L.) Gaertn

Hindi name: *Mandua*; Telugu name: *Ragulu*

It is an annual plant extensively grown as cereal in the dry areas of India, especially in the southern part. It contains high amounts of calcium, proteins with well-balanced essential amino acids along with vitamin A, vitamin B and phosphorous. Its high fibre content prevents constipation, high blood pressure and intestinal cancer.

Finger millet is commonly used in South Indian Kitchens. It is rich in calcium, about ten times that of rice or wheat. It is an important ingredient in the food of babies, as it contains plenty of calcium and iron. Protein content in finger millet is high making it an important factor in preventing malnutrition. Also making it an ideal food for diabetics as it has demonstrated ability of controlling blood glucose levels and hyperglycemia.





Finger Millet Onion *Chapati*

Ingredients:

Finger millet flour - 1 cup , onion, salt, green chilli, curd, water, coriander and oil - as required.

Preparation Method:

- Add all the ingredients and knead it to a soft dough.
- Heat a pan, grease it with oil.
- Now make equal size balls of the dough and make small *roti* with hand by applying little oil to your palms.
- Transfer it to the pan and cook it on a low flame. Once done flip it over the other side.
- The prepared *roti* can be enjoyed with curd, pickle or any curry.

Finger Millet *Laddu*

Ingredients:

Finger millet flour - 1 cup, sugar - 1/2 cup powdered, ghee - 3 tsp, milk - 1/4 cup, cardamom powder - 1 tsp, coconut gratings and dry fruits - as required chopped finely

Preparation Method:

- Finger millet flour until roasted aroma appears.
- Roast dry fruits in ghee, heat milk and melt the jaggery.
- Add all roasted ingredients together and mix well.
- Shape into round lemon sized balls manually and serve.





Finger Millet Muruku

Ingredients:

Finger millet flour – 1 cup, rice flour – 1 cup, sesame seeds – 2 tsp, turmeric – 1/2 tsp, salt – 1 tsp, chilli powder – 2 tsp, tymol seeds – 1/2 tsp; water – as required; oil – for frying.

Preparation Method:

- Prepare dough with all ingredients and water.
- Fill the dough in hand operated *muruku* making machine
- Prepare 3-4 rounds of *muruku* on a cloth
- Fry the prepared *muruku* in oil. Put the flame on low to ensure proper frying
- After frying put the *muruku* on paper and cool it and serve as evening snack.

Soft Finger Millet *Mudde*

Ingredients:

Finger millet flour - 1/4 cup and water - 1 cup

Preparation Method:

- Mix about 2 tsp of finger millet flour with water.
- In an aluminum or thick-bottomed utensil, boil water and add salt.
- Add finger millet flour and water mixture and stir continuously.
- Add the remaining finger millet flour and simmer for 3-4 minutes.
- Transfer half of liquid to a utensil.
- Stir the paste till it becomes a uniform paste without lumps add the transferred liquid again to the mixture
- Cover the utensil and cook in sim mode for another 2-3 minutes.
- Roll the paste into a ball
- Soft finger millet *mudde* or soft finger millet ball is ready.
- Serve hot with *sambar* or *chutney*.





Finger Millet *rawa* Chocolate Pudding

Ingredients:

Finger millet *rawa* – 1/4 cup, finger millet flour – 1/4 cup, water – 3/4 cup, salt – a pinch, boiled milk – 1/4 cup, chocolate chopped – 1/4 cup and chopped nuts – 1 tsp

Preparation Method:

- Boil water with a pinch of salt and add the finger millet *rawa* to the boiling water and add milk to the mixture
- Add the finger millet flour to it and do not stop stirring, else lumps will form.
- Keep stirring for 2 minutes and add chopped dark chocolate mix and stir well.
- Serve hot or cold with chopped nuts.

Finger Millet Vermicelli *Kheer*

Ingredients:

Finger millet vermicelli – 1 cup, dryfruits, ghee, water, sugar, milk and cardamom powder - as required.

Preparation Method:

- Boil milk in a thick bottomed pan.
- Roast dryfruits, finger millet vermicelli in ghee separately
- Boil milk and add roasted vermicelli and cook for 3 min. add sugar and mix well.
- When contents starts boiling, add cardamom powder and dryfruits.
- Cool and serve





Finger Millet Vermicelli Upma

Ingredients:

Finger millet vermicelli - 1 cup, chopped onions, green chillies, mustard seeds, blackgram *dal*, curry leaves, ground nut, water and oil - as required.

Preparation Method:

- Roast the finger millet vermicelli in little oil
- Make seasoning with mustard seeds, *blackgram dal*, cumin, ground nuts and curry leaves
- Pour water and boil, add salt to taste
- Cook vermicelli in above boiled water and serve hot.

Finger Millet Cake

Ingredients:

Finger millet flour - 100 g, essence - 3 ml, fat - 100 g, baking powder - 3 g, egg - 2, cocoa powder - 5 g, sugar - 100g, salt - 2 g and milk - 20ml

Preparation Method:

- Pre heat oven to 180°C, sieve all dry ingredients thrice for uniform mixing.
- Sugar powder and egg whites are to be beaten well and add milk, essence, egg yolk and mix well.
- Add finger millet flour, salt, cocoa powder and baking powder and make into fine batter.
- Put the batter in baking bowl and place in the oven at 180°C for 25-30 min.
- Take the cake out and wait for 10 min until it cools.
- The cake is removed from mould after at least 15 min. cut into pieces and serve.





RECIPES FROM FOXTAIL MILLET

FOXTAIL MILLET

Scientific name: *Setaria Italica* (L.) P. Beauvois

Hindi name: *Kangni*; Telugu name: *Korralu*

Foxtail millet is one of the oldest cultivated millets. Three to four decades ago, foxtail millet was consumed as the staple food. It has double quantity of protein content compared to rice. It controls blood sugar and cholesterol. It increases disease resistant capacity when consumed and is considered ideal food for people suffering from diabetes and gastric problem.

Foxtail millet provides a host of nutrients, has a sweet nutty flavour and is considered to be one of the most digestible and non-allergic grains available. It contains fibre, protein, calcium and vitamins. It is a nutritive food for children and pregnant women. It is rich in dietary fibre and minerals such as copper and iron that keep one's body strong and immune.





Foxtail Millet Kheer

Ingredients:

Dehulled foxtail millet grain – 1 cup, dry fruits, ghee, water, sugar, milk, cardamom powder – as required

Preparation Method:

- Cook the dehulled foxtail millet in boiling water for 5 min.
- Roast dryfruits in ghee
- Boil the water and milk, then add the cooked millet, add sugar and stir slowly for 10-15 minutes until it is cooked.
- Add cardamom powder and decorate with cashew nuts and other dry fruits.
- Serve hot as a traditional sweet

Foxtail Millet Mango Rice

Ingredients:

Foxtail millet – 1 cup, water – 2 cups, raw mango, grated – 1 or per taste, groundnuts – 2 tsp, seasoning – curry leaves, chillies, mustard seeds, blackgram *dal*, turmeric, asafoetida, oil, salt to taste

Preparation Method:

- Cook the millet in water and let it cool before mixing the rest of the ingredients.
- Fry groundnuts in oil, keep aside.
- Prepare the seasoning.
- Add grated mango and saute for a minute.
- Add the cooked millet and mix
- Tangy mango rice is ready, serve hot.





Foxtail Millet Cutlet

Ingredients:

Dehulled foxtail millet - 100 g, potatoes - 20 g, carrots - 20 g, beans - 20 g, salt - 2 g, pepper - 5 g, chat masala - 5 g, bread crumbs - 20 g, green chillies - 5 g, water - as required and oil - for shallow or deep frying

Preparation Method:

- All the chopped vegetables and foxtail millet grain are cooked and kept aside.
- In a pan add one table spoon of oil, ginger garlic paste, sliced green chillies and fry them until light brown colour appears.
- Add the cooked millet, *chat masala*, pepper and cooked vegetables and mix them well.
- Make them into cutlet shapes, coat the cutlets with foxtail bread crumbs.
- Shallow or deep fry in a pan them until light brown colour appears.
- Serve with tomato sauce or *chutney*.

Foxtail Millet Coconut Rice

Ingredients:

Foxtail millet - 1 cup, coconut grated - 1 cup, ghee - 2 tsp, coriander leaves - 2 tsp and salt - as desired.

Preparation Method:

- Foxtail millet is soaked for 2 hr and cooked fully.
- Add ghee and cumin, green leaves, ginger, leaves, red chilli, curry leaves and saute them in a pan.
- Add cooked foxtail and grated coconut and cook for two min.
- Add salt as per taste and serve hot.



Foxtail Millet Vegetable *Biryani* / Chicken *Biryani*

Ingredients:

Foxtail Millet - 1 1/2 cup, onion sliced - 2, carrots - 1/2 inch pieces (2), french beans - 1/2 inch pieces (15), green peas shelled - 1 cup, salt - as desired, green cardamoms - 8, black cardamom - 1, cloves - 15, cinnamon - 1/2 inch stick, bay leaf - 1, caraway seeds (shahi jeera) - 1/2 tsp, ginger-garlic paste - 1 1/2 tsp, turmeric powder - 1 tsp, Red chilli powder - 1 tsp, coriander powder - 1 tsp, tomatoes - 1 cup, garam masala powder - 1 tsp, Lemon juice - 1 tsp, food colour - a pinch (If desired), fresh coriander leaves chopped - 2 tsp, Fresh mint leaves chopped - 2 tsp

Preparation Method:

- Boil Foxtail millet in four cups of salted boiling water with cardamom, cloves and cinnamon, until three-fourth done. Drain excess water and set aside.
- Boil all the chopped vegetables and keep aside.
- Add green cardamoms, cloves, black cardamom and cinnamon along with bay leaf and caraway seeds and roast in a thick bottom pan.
- Add tomatoes, ginger-garlic paste, deep fried onions, carrot, French beans, and boiled green peas. Sprinkle salt, cover and cook on medium heat for two minutes.
- Add turmeric powder, red chilli powder, coriander powder, *garam masala* powder and mix well. Simmer for two minutes.
- Arrange a layer of millet at the top over that arrange half the cooked vegetables.
- Sprinkle fried onions, lemon juice, food colour mixed in milk *garam masala* powder, the coriander leaves and the mint leaves.
- Cover with a lid and cook. Let it stand for five minutes. Serve hot.
- NOTE: For chicken biryani in the place of vegetables chicken is to be substituted, remaining whole procedure is same.





Foxtail Bread

Ingredients:

Foxtail millet flour – 1 cup, *maida* – 1 cup, milk – 15 ml, salt – 1 g, yeast – 2 g, sugar – 5 g, water – 30 ml, egg-1 and oil – for greasing

Preparation Method:

- In a large bowl, dissolve yeast in warm water. Add the sugar, salt, oil keep aside for 2 minutes.
- Add the foxtail millet flour, *maida*, milk and mix them into a smooth dough.
- Knead until smooth and elastic, about 8 to 10 minutes and place in a greased bowl.
- Cover and let rise in a warm place until doubled, about 1 ½ hrs. and set the oven temperature to 190°C.
- After 1 ½ hr punch down the dough onto a floured surface.
- Shape them into a loaf and place in a greased loaf pan and bake them at 190°C for 15 to 20 mins.
- Remove from pan and cool them and cut them into loaves and pack.

Foxtail Millet *Bisebelle baat*

Ingredients:

For *masala* powder - coriander seeds, red dry chillies, *chana dal*, fenugreek seeds, for *sambar* - cooked *toor dal* - 1 cup, lemon - 1, tamarind - 1, small onion- 5-7, mixed vegetables - 2 cups (carrot, drumstick, beans and potato), oil - 2 tsp, curry leaves - 10, mustard seeds - 1/4 tsp, turmeric powder - 1/4 tsp, broken red chillies - 2, asafoetida- a generous pinch, salt to taste, coriander leaves - 1 tsp, foxtail millet - 1 cup, water - 2 cups, salt a pinch, coriander leaves - 2 tsp

Preparation Method:

- Add tamarind water, vegetables, salt and *sambar* spice powder in a pressure cooker and cook till two whistles.
- Cook the foxtail millet, *toor dal*, turmeric powder, salt and water in another pressure cooker until two whistles.
- For seasoning, saute mustard seeds, cumin seeds, red chilli, curry leaves in ghee and keep aside.
- Add the spicy vegetable tamarind curry to the cooked millets and mix together till a mish mash.
- Add the seasoning and transfer the *bisebelle baat* to a serving bowl. Sprinkle the chopped coriander and serve hot.





RECIPES FROM KODO MILLET


KODO MILLET

Scientific name: *Paspalum scrobiculatum* (L.)

Hindi name: *Kodon*; Telugu name: *Varagu*

Kodo millet was domesticated in India almost 3000 years ago. It is an annual tufted grass that grows up to 90 cm high. The grain is enclosed within hard, corneous, persistent husks that are difficult to remove. It has the highest dietary fiber amongst all the millets.

It forms the main stay of the dietary nutritional requirements. It has high protein content (11%), low fat (4.2%) and very high fibre content (14.3%). Kodo millet is very easy to digest, it contains a high amount of lecithin and is excellent for strengthening the nervous system. It is rich in B vitamins, especially niacin, B6 and folic acid, as well as the minerals such as calcium, iron, potassium, magnesium and zinc. It contains no gluten and is good for people who are gluten intolerant. Regular consumption of kodo millet is very beneficial for postmenopausal women suffering from signs of cardiovascular disease, like high blood pressure and high cholesterol levels.



Kodo Millet *Upma*

Ingredients:

Kodo millet grain - 1 cup, chopped onions, green chillies, carrot, beans, potato ginger, mustard seeds, blackgram *dal*, bengal gram *dal*, curry leaves, water and oil – as required.

Preparation Method:

- Wash kodo millet two or three times, then drain the water completely and keep it aside.
- Chop onions, green chillies and veggies finely. Grate the ginger.
- Heat the oil in a pressure cooker, add mustard seeds when it splutters, add blackgram *dal*, *chanadal*, curry leaves and green chillies.
- When *dal* turns golden brown add onions, ginger, turmeric, saute till onions turns golden brown.
- Add carrots, beans, and potato saute for 2 to 3 minutes. Then add kodo millet, saute for 1 minute, till everything combines.
- Then add water and salt. When water starts boiling close the lid, and cook in moderate flame for 3 whistles.
- When pressure subsides, open the lid and serve hot with any type of *chutney* or *sambar*.





Kodo Millet *Methi* Rice

Ingredients:

Kodo millet - 1 cup, water - 3 cup, chopped *methi* leaves - 2 cups, chopped onions - 1/2 cup, chopped tomatoes - 1/2 cup, ginger garlic paste - 2 tsp, green chillies - 3, curry leaves - 8, salt - to taste; whole spices: bay leaf - 1 and clove - 2

Preparation Method:

- Wash kodo millet rice and keep it aside. Chop all vegetables and keep it ready.
- Wash the *methi* leaves and chop the *methi* leaves.
- Heat a teaspoon of oil in a pressure cooker. Add the whole spices and fry for a few minutes. Add curry leaves, chopped onions and fry till translucent.
- Add green chillies and ginger-garlic paste and fry for a few minutes.
- Add 3 cups of water and when water comes to a boil, add kodo millet rice, chopped *methi* leaves and cook till 1 whistle in medium flame
- Serve hot with some *raitha*.

Source: cookingwithmillets.com

Kodo Millet *Pulao*

Ingredients:

Kodo millet - 1 cup, water - 1 & 1/2 cups, chopped carrot, beans, green peas - 1 cup, onion - 1, ginger garlic paste - 1 tsp, green chilli - 2, mint leaves - 12, salt - as needed; To temper: Ghee/ oil - 3 tsp, cinnamon - 1 inch piece, fennel seeds - 1 tsp and bay leaf - 1

Preparation Method:

- Heat a small pressure cooker and saute with oil/ ghee and add cinnamon, fennel and bay leaf.
- Stir and add onion and ginger garlic paste.
- Add the chopped veggies, mint leaves and salt
- Add washed, drained millet to it and mix well and cook.
- Add water, salt and bring to boil, mix well and cook for a whistle in medium or low flame.
- Serve hot garnish with coriander leaves.

Source: cookingwithmillets.com





Kodo Millet Coriander Rice

Ingredients:

Kodo millet - 1 cup, water - 2 cups, onion-1, carrot - 1 cup, tomato - 2, , curry leaves- 1 spring bay leaf - 1; Coriander *chutney*: Coriander leaves - 1 cup, mint leaves - 1/4 cup, green chilli-1, cloves - 1, garlic - 1, ginger - 1/2 inch and salt to taste and oil - 2 tsp

Preparation Method:

- Cook kodo millet rice in a pressure cooker with water, salt to taste and bay leaf at medium flame for 1 whistle.
- Prepare coriander *chutney* with minimum water. Chop all the vegetables.
- In a hot pan, take 1 tsp of oil. Add whole spices to it and fry for a minute.
- Add chopped onion and fry till translucent.
- Add chopped carrots and stir well, add mint *chutney*. Cook the *chutney* till the raw taste of coriander disappears. Add salt to taste.
- Add the cooked kodo millet and mix evenly. Remove from flame. NOTE: Millet rice has to cool otherwise it will become mushy.
- Serve hot with some *raitha*

Source: cookingwithmillets.com

Kodo millet *Payasam*

Ingredients:

Kodo millet - 150 g, sugar - 250 g, milk - 250 ml, saffron - 4-5 threads, dry fruits (cashew, almond and pista) - 50 g and ghee - 30 ml.

Preparation Method:

- Cook together kodo millet, saffron and milk on slow heat until the millet gets mashed.
- Add sugar and stir gently to cook *payasam*.
- Heat ghee in a pan add all dry fruits and roast until golden colour and add to the cooked *payasam*.
- It can be served hot or cold.

Source: ICAR-CIAE, Bhopal



Kodo Millet Adai

Ingredients:

(To soak) kodo millet – 1/2 cup, *toor dal* – 1/4 cup, *channa dal* – 1/4 cup, *moong dal* – 1 tsp and *urad dal* – 1 tsp; (For seasoning) Red chillies – 2, fennel seeds – 1 tsp (optional), small onion – 1/4 cup chopped finely, curry leaves – few torn into pieces, coriander leaves – 1 tbsp, mint leaves – 1 tbsp finely chopped and salt – to taste

Preparation Method:

- Take soaking ingredients and soak for 4 hrs. Drain water and set aside.
- Take red chillies and fennel seeds in a mixer, add little of mixed millet mixture and grind it to a coarse mixture.
- Add chopped onion, coriander leaves and required salt. The batter should be slightly runny in between *idli* and *dosa* batter consistency.
- Heat the *adai* (or *dosa* pan) pan, grease with little oil, make round *adai* and cook till golden brown and crisp at the edges and add onion and ginger garlic paste.
- Add the chopped veggies, mint leaves and salt.
- Serve hot garnish with coriander leaves.
- Serve hot with any *chutney* of your choice.

Source: cookingwithmillets.com



A close-up photograph of barnyard millet panicles, showing the intricate structure of the seed heads. The panicles are a mix of green and brown, indicating they are in the process of maturing. The background is a soft-focus green, suggesting a field of the same crop.

RECIPES FROM BARNYARD MILLET


BARNYARD MILLET

Scientific name: *Echinochloa crusgalli* (L.)P. Beauvois

Hindi name: *Sanwa*; Telugu name: *Oodallu*

Barnyard millet is a good source of protein, which is highly digestible and is an excellent source of dietary fiber with good amount of soluble and insoluble fractions. The carbohydrate content of barnyard millet is low and slowly digestible, which makes the barnyard millet a nature's gift for the modern mankind who is engaged in sedentary activities. In it millet the major fatty acid is linoleic acid followed by palmitic and oleic acid. It also shows a high degree of retrogradation of amylase, which facilitates the formation of higher amounts of resistant starches. Hence it can be potentially recommended for the patients with cardiovascular disease and diabetes mellitus. Barnyard millet is most effective in reducing blood glucose and lipid levels.

In today's scenario of increased diabetes mellitus, this millet could become an ideal food. It is also an appropriate food for patients intolerant to gluten which causes celiac disease.

A small, detailed photograph of a single barnyard millet panicle, showing the individual grains and the structure of the seed head. The panicle is green and appears to be in the early stages of maturation.

Barnyard Millet Cutlet

Ingredients:

Dehulled barnyard millet grains - 100 g, potatoes - 20 g, carrots - 20 g, beans - 20 g, salt - 5 g, pepper - 5 g, *chat masala* - 5 g, bread crumbs - 20 g, *channa dal* - 30 g, green chillies - 5 g, water - as required and oil - for shallow or deep frying

Preparation Method:

- Cook barnyard millet in boiling water and fluff it with a fork and keep it aside.
- Mix *channa dal* flour powder with curd, boil the vegetables and saute finely chopped onions, green chilli, garlic, ginger and saute until onions turn transparent in oil.
- Add salt, pepper powder, turmeric powder to the cooked vegetables and add cooked barnyard millet, finely chopped coriander leaves and mix well. Cook for a further few seconds.
- Leave it to cool. Divide the mixture equally and shape into *cutlet* and shallow fry the *cutlets* both sides until golden brown or deep fry them in oil.
- Serve with sauce.





Barnyard Maheri

Ingredients:

Barnyard millet – 50 g, *shama* rice – 100 g, butter milk – 550 ml, salt – to taste, ghee – 20 ml, curry leaves – a few, mustard seeds – 2 g and chopped green chilli – 10 g.

Preparation Method:

- Clean, soak and boil barnyard millet and *shama* rice for 30 min.
- Strain and cook in butter milk until well done
- Heat ghee in a thick bottom pan, add mustard seeds, green chilli and curry leaves
- Pour over the cooked rice and cover with a lid for a short time
- Mix well and add seasoning.
- Serve hot.

Source: ICAR-CIAE, Bhopal

Barnyard Indiana

Ingredients:

Barnyard millet – 150 g, small dices of vegs. (carrots, french beans, cauliflower and green peas) – 150 g, salt – to taste, green chilli chopped – 15 g, ghee – 50 g, curry powder – 2 tsp, coriander leaves, - as required, asafoetida – a pinch, cumin seed – 2 g and water – ½ cup.

Preparation Method:

- Clean and soak the millet in water for 15 min
- Heat ghee in cooker, add cumin, asafoetida and diced vegetables along with curry powder and saute.
- Add presoaked millets and mix well
- Add water, salt and pressure cook with one whistle
- Open and garnish with ghee, chopped coriander leaves and serve hot

Source: ICAR-CIAE, Bhopal





Barnyard Millet Pudina Rice

Ingredients:

Barnyard millet - 1 cup, water - 2 cups, onion-1, carrot - 1 cup, tomato - 2, , curry leaves- 1 spring bay leaf - 1; *pudina* (mint) *chutney*: Mint leaves - 1cup, coriander leaves - 1/4 cup, green chilli-1, cloves - 1, garlic - 1, ginger - 1/2 inch and salt to taste and oil - 2 tsp

Preparation Method:

- Cook barnyard millet in a pressure cooker with water, salt to taste and bay leaf at medium flame for 1 whistle.
- Prepare mint *chutney* with minimum water. Chop all the vegetables.
- In a hot pan, take 1 tsp of oil. Add whole spices to it and fry for a minute.
- Add chopped onion and fry till translucent.
- Add chopped carrots and stir well, add mint *chutney*. Cook the *chutney* till the raw taste of mint and coriander disappears. Add salt to taste.
- Add the cooked barnyard millet and mix evenly. Remove from flame.
- Serve hot with some *raitha*

Source: cookingwithmillets.com

Barnyard Payasam

Ingredients:

Barnyard millet - 150 g, sugar - 250 g, milk - 250 ml, saffron - 4-5 threads, dry fruits (cashew, almond and pista) - 50 g and ghee - 30 ml.

Preparation Method:

- Cook together barnyard millet, saffron and milk on slow heat until the millet gets mashed.
- Add sugar and stir gently to cook *payasam*.
- Heat ghee in a pan add all dry fruits and roast until golden colour and add to the cooked *payasam*.
- It can be served hot or cold.

Source: ICAR-CIAE, Bhopal



Barnyard Millet Pizza

Ingredients:

Pizza base: Barnyard millet, ½ cup, *maida* - ½ cup, baking soda - ½ tsp, salt - as required, oil - 1-2 tsp (for cooking the crusts), water - if needed; millet crust pizza – Onions, green capsicum, tomatoes cubed - 1/3 cup, sweetcorn kernels - a few tomato sauce - 1/3 cup and mozzarella cheese - as required

Preparation Method:

- Soak the millet in enough water for at least an hour and grind into a smooth paste.
- Add baking powder, *maida* along with salt and mix well (you can also ferment the batter in a warm place for 6 hrs)
- Heat a flat pan. Pour a ladle full of the prepared batter – don't spread it. Spread few drops of oil all around the crust, cook and flip it to the other side.
- Pre-heat the oven at 180°C for about 5-7 mins.
- Meanwhile, line a baking tray with aluminum foil or parchment paper. Place these prepared pizza crusts on the baking tray.
- Spread the tomato sauce and mozzarella cheese over the sauce. Place cubed onions, capsicum and sweetcorn all over the pizza.
- Bake/Grill at 180°C for about 7-10 mins, until the cheese is bubbly and the vegetables are toasted.
- Serve hot with red chilli flakes and mixed Italian herbs on top!

NOTE: There can be a few cracks over the edges of the pizza crust as it is gluten free, but that not hamper the taste

Source: www.cookingfromheart.com



A close-up photograph of several panicles of proso millet, showing the individual grains in detail. The panicles are green and appear to be in the early stages of ripening. The background is slightly blurred, showing more of the plant and some leaves.

RECIPES FROM PROSO MILLET

PROSO MILLET

Scientific name: *Panicum miliaceum* (L.)

Hindi name: *Barree*; Telugu name: *Varigalu*

Proso millet is a short season crop that grows in low rainfall areas. This millet can be cultivated along with red gram, maize and sorghum. It releases energy over a longer period of time after consumption allowing one to work from morning to evening without getting tired. The same is not true with rice. This has much protein crude fiber, minerals and calcium.

Health benefits of proso millet comes from its unique properties. It is completely gluten free and has significant amounts of carbohydrate and fatty acids. It is cheaper source of manganese as compared to other conventional sources like spices and nuts. It contains high amounts of calcium which is essential for bone growth and maintenance. It has been shown to reduce cholesterol levels and also reduce the risk of heart diseases. It also prevents breast cancer among other diseases.



Proso Millet Rawa Idli

Ingredients:

Proso millet *idli rawa*- 1 cup, *urad dal* - 1 cup and salt - to taste

Preparation Method:

- Soak *urad dal* in water for 4-6 hr and drain out the water and grind it
- To the batter, add one cup of proso millet *idli rawa*, salt and allow to ferment overnight.
- Pour out the batter into *idli* moulds and cook in *idli* cooker for 7-10 min.
- Serve hot with coconut *chutney* and *sambar*.

Source: cookingwithmillets.com

Proso Millet Khaja

Ingredients:

Proso millet flour - ½ cup, *maida*- ½ cup, sugar - ½ tsp and oil- for frying.

Preparation Method:

- Prepare dough with proso millet flour and *maida*. Add small quantity of hot oil while dough making.
- Roll the *roti* from the dough into 1 inch thickness and roll into the center.
- Cut the roll into small shapes (*khajas*).
- Add sugar to water and boil till single thread consistency.
- Fry the prepared *khaja* in oil.
- Excess oil is drained and put it on tissue paper.
- Add the prepared *khajas* in sugar and soak for 5 min and serve.





Proso Millet Burfi

Ingredients:

Proso millet flour - 1 cup, powdered jaggery - ½ cup, ghee - 2 tsp, water - ¼ cup, cardamom powder - 1/8 tsp and sliced almonds - 1 tsp

Preparation Method:

- Grease a plate with ghee and keep it aside.
- Heat the jaggery in a pan with ¼ cup of water till single thread consistency. Keep it aside.
- Add little ghee in a pan and add proso millet flour and fry until nice aroma comes.
- Then add the jaggery syrup and cardamom powder and mix it quickly.
- Add remaining ghee and stir continuously for 2-3 min or till the mixture leaves the sides of the pan.
- Spread it in a greased plate and garnish with chopped nuts. Allow it to cool down and cut them into small pieces.
- Healthy and yummy proso millet burfi is ready.

Source: cookingwithmillets.com

Proso Millet Samosa

Ingredients:

Proso millet flour – 1 cup, maida – 1 cup, potatoes – 1 cup, boiled peas, onions, green chillies and curry leaves.

Preparation Method:

- Take one cup of proso millet flour and one cup of maida. Mix well and add required amount of water to make dough.
- Make small chapatti balls and spread the dough with roller stick and cut into half's.
- Mash boiled potatoes, add chopped onions, green chilies and curry leaves.
- Make seasoning with chopped onions, green chilies, curry leaves and boiled mashed potatoes, boiled peas and salt to taste.
- Fill the above mixture in each half fold in triangular shape and deep fry
- Serve hot with chutney or tomato sauce.

Source: cookingwithmillets.com





Proso Millet Payasam

Ingredients:

Dehulled proso millet - 1 cup, dry fruits, ghee, water, sugar, milk, cardamom powder – as required

Preparation Method:

- Cook the dehulled proso millet in boiling water for 5 min.
- Roast dryfruits in ghee
- Boil the milk and then add the cooked millet, add sugar and stir slowly for 10-15 minutes until it is cooked.
- Add cardamon powder and decorate with cashew nuts and other dry fruits.
- Serve hot as a traditional sweet





RECIPES FROM LITTLE MILLET

LITTLE MILLET

Scientific name: *Panicum sumatrense*

Hindi name: *Kutki*; Telugu name: *Saamalu*

Little millet is grown throughout India and is one of the traditional crops. It is mostly mix cropped with other millets, pulses and oilseeds. It is generally consumed as rice and any recipe that demands staple rice can be prepared using little millet. This species of cereal is similar in habit to the proso millet except that it is smaller. It is an annual herbaceous plant, which grows straight or with folded blades to a height of 30 cm to 1 m. The leaves are linear, sometimes with hairy lamina and membranous hairy ligules.

Little millet is reported to have 37% to 38% of dietary fiber, termed as a nutraceutical and highest among cereals. Thus, it is a complete food ingredient suitable for large scale utilization as processed products, snacks, baby foods etc., and also plays a major role in propagating food security among under developed and developing countries.



Little Millet Payasam

Ingredients:

Dehulled little millet – 1 cup, dry fruits, ghee, water, sugar, milk, cardamom powder – as required

Preparation Method:

- Cook the dehulled little millet in boiling water for 5 min.
- Roast dryfruits in ghee
- Boil the milk and then add the cooked millet, add sugar and stir slowly for 10-15 minutes until it is cooked.
- Add cardamom powder and decorate with cashew nuts and other dry fruits.
- Serve hot as a traditional sweet

Little Millet Curd Rice

Ingredients:

Little millet - 1/2 cup, water - 2 cups, curd - 3/4 cup, milk - 1/4 cup, carrot - 3 tbsp, grated coriander leaves - 2 tsp finely chopped, salt - to taste; To temper: Oil - 1 tsp, mustard seeds - 1/2 tsp, split *urad dal* - 1/2 tsp, curry leaves – few, green chilli - 1 finely chopped and ginger - 1/4 inch piece

Preparation Method:

- Boil water, add the millet and cook till millet becomes soft.
- Then take the millet in a mixing bowl and mash it and add curd, then milk and mix it up well.
- Heat oil in a *tadka* pan and add the seasoning 'to temper' let it splutter.
- Transfer the tempering to the rice along with grated carrot, coriander leaves and required salt. Mix well.
- Serve chilled and garnish with carrots and coriander leaves.

Source: cookingwithmillets.com





Little Millet Mushroom *Biryani*

Ingredients:

Little millet - 1 cup, mushroom - 100 g, onion - 1, tomato - 1, ginger garlic paste - 1 tsp, turmeric powder - 1/2 tsp, red chilli powder - 1 tsp, *garam masala* - 1 tsp, salt - to taste, water - 2 cups (for millet) + 1/4 cup (for mushroom *masala*); To grind to a paste: Coriander leaves - 1/2 cup, mint leaves - 1/2 cup, green chillies - 1; To temper: Ghee - 2 tsp, oil - 1 tsp, cloves - 4, cardamom - 1, bay leaf - 1, cinnamon - 1 stick, star anise - 1, mace - small piece, fennel seeds - 1 tsp, cumin seeds - 1 tsp and curry leaves - few

Preparation Method:

- Dry roast the little millet for 1-2 min. Grind the under *masala* with little water to a fine paste. Keep aside
- Heat ghee and oil in a pressure cooker, add the items to temper, and fry till aroma comes. Add the chopped onions and fry till golden brown. Add the tomatoes, ginger garlic paste, *masalas*, salt and the coriander-mint paste. Mix well.
- Saute well and then add the chopped mushrooms, water and cook.
- Once it starts to boil, add the little millet, water, few coriander and mint leaves and pressure cook for 1 whistle.
- Consume hot with any *gravy* and onion *raita*. NOTE: Use fresh and clean mushrooms.

Source: cookingwithmillets.com





Little Millet *Pudina* Rice

Ingredients:

Little millet - 1 cup, water - 2 cups, onion-1, carrot - 1 cup, tomato - 2, , curry leaves- 1 spring bay leaf - 1; *pudina* (mint) *chutney*: Mint leaves - 1cup, coriander leaves - 1/4 cup, green chilli-1, cloves - 1, garlic - 1, ginger - 1/2 inch and salt to taste and oil - 2 tsp

Preparation Method:

- Cook little millet rice in a pressure cooker with water, salt to taste and bay leaf at medium flame for 1 whistle.
- Prepare mint *chutney* with minimum water. Chop all the vegetables.
- In a hot pan, take 1 tsp of oil. Add whole spices to it and fry for a minute.
- Add chopped onion and fry till translucent.
- Add chopped carrots and stir well, add mint *chutney*. Cook the *chutney* till the raw taste of mint and coriander disappears. Add salt to taste.
- Add the cooked little millet rice and mix evenly. Remove from flame. NOTE: Millet rice has to cool otherwise it will become mushy.

• Serve hot with some *raitha*

Source: cookingwithmillets.com

Little Millet Tomato Rice

Ingredients:

Little millet - 1 cup, onion-1, carrot - 1 cup, tomato - 2, green chilli-1, curry leaves- 1 spring, ginger-1tsp [finely chopped], mustard seeds-1 tsp, bengal gram-1 tsp, *urad dal*-1 tsp, turmeric powder - 1/4 tsp, red chilli powder - 1/4 tsp, coriander leaves-2 tsp [chopped], water-1 3/4 to 2 cups, salt to taste and oil - 2 tsp

Preparation Method:

- Wash and little millet for 15 min.
- Heat oil in a pressure cooker add mustard seeds and let its splutter.
- Then add bengal gram, *urad dal* saute gently then add onion, ginger, green chilli, green peas, carrot and curry leaves saute.
- Add tomato, turmeric and red chilli powder mix well till soft.
- Add water and salt and mix well and let it boil.
- Then add little millet mix well then cover it and cook for 3 whistle.
- Then add coriander leaves mix well and serve hot with coconut *chutney* or pickle.

Source: cookingwithmillets.com





Vegetable *Roti*

Ingredients:

Sorghum flour – ½ cup, pearl millet – ½ cup; cooked - carrot, potatoes and peas – as required.

Preparation Method:

- Combine all the ingredients in a deep bowl, mix well and knead into a soft dough using enough water.
- Divide the dough into 4 equal portions and roll out using a little sorghum flour for rolling.
- Heat a non-stick pan and cook each roti, using ½ tsp of ghee or oil, till golden brown spots appear on both the sides.
- Serve with any curry or *chutney*.

Mixed Millet *Paniyaram* (*ponganalu*) – Sweet & Spicy

Ingredients:

Sorghum – ½ cup, little millet – ½ cup, foxtail millet – ½ cup, barnyard millet – ½ cup, pearl millet – ½ cup, , parboiled rice – ½ cup, blackgram *dal* – 1 cup, jaggery – ½ cup, fenugreek – 3 tsp and oil – for shallow frying

Preparation Method:

- Soak all the ingredients for 2 hours.
- Drain them and grind it into a smooth batter and ferment for 4 hours.
- Take the required amount of batter add melted jaggery
- Heat *paniyaram* pan on low-medium flame and add 1 tsp of oil in every well.
- Pour sweet *paniyaram* batter to the ¾ of the well, and cover the lid for 1 minute on low flame and flip the each *paniyaram* with the help of skewer or wooden stick.
- After it gets cooked take out from the well and keep it in bowl.
- Serve it hot and spicy *paniyaram* can also be made by adding veggies with tempering.





Millet Bhel

Ingredients:

Sorghum- ½ cup, pearl millet - ½ cup, foxtail millet - ½ cup, finger millet - ½ cup, *kabuli channa* - ¼ cup; *chat masala*, onion, tomatoes, green chilli, salt, and roasted cumin powder - as required

Preparation Method:

- Wash and soak the millets and *kabuli channa* in enough water overnight
- Pressure cook them in medium heat till two whistles.
- Rinse the cooked millets and saute them on a low flame in little oil by stirring often.
- Add the chopped onion, tomatoes, green chili, salt, roasted cumin powder and *chat masala* and mix well.
- Serve millet *bhel* in individual bowls or plates. If needed sprinkle few drops of lemon juice on each serving topped with chopped coriander leaves.

Millet Patties

Ingredients:

Sorghum- ½ cup, little millet - ½ cup, foxtail millet - ½ cup, barnyard millet - ½ cup, pearl millet - ½ cup, *rajma* - ½ cup; finely chopped onions, capsicum, ginger, cilantro and shredded carrot, potato, corn, bread crumbs and salt - as required.

Preparation Method:

- Wash and soak millets in enough water for 5-10 minutes.
- Boil the drained millet in 1.5 cups of water and cook in medium heat for 5-7 minutes till all the millets are cooked
- In a processor or blender, mash cooked vegetables and add cooked millet and rest of the ingredients and mix well.
- Then divide the mixture into small ball sized portions and flat it between palms
- Heat a *tawa*/griddle, smear with oil once it is hot and shallow fry patties by flipping on both sides
- Serve the delicious millet patties with ketchup or *chutney*.





Multi Millet *Khakra*

Ingredients:

Sorghum flour – 25 g, pearl millet flour – 25 g, finger millet flour – 25 g, foxtail millet flour – 25 g, bengal gram flour – 25 g, black gram flour – 25 g, salt – 3 g, coriander powder – 2 g, *garam masala* powder – 2 g and water – 30 ml

Preparation Method:

- Boil water and add all the above ingredients together by adding water.
- Make in to dough and roll in to small balls.
- Make the balls into small *rotis*.
- Bake them in *roti* baker, baking on both sides.
- Cool them and store.

Millet *Idli*

Ingredients:

Millet *rawa* – 3 cups, black gram *dal* – 1 cup, salt – as desired.

Preparation Method:

- Millet *rawa* and black gram *dal* are taken separately and soaked in water for 3 hrs.
- Black gram *dal* is then grinded in a wet grinder until it becomes a soft batter.
- Water is drained out from the soaked millet *rawa* and is mixed with the soft batter.
- The mixture is mixed thoroughly and allowed to ferment for 2 hr.
- After that little salt is added to the batter for taste and *idlis* are steamed in *idli* steamer.
- *Idli* are cooked till they get soft texture and served hot with *chutney*.





Millet *Laddu*

Ingredients:

Sorghum *rawa* - 1/2 cup, pearl millet flour - 1/4 cup, finger millet flour - 1/4 cup, sugar - 3/4 cup, coconut powder, dryfruits, ghee, cardamon powder and milk - as required.

Preparation Method:

- Heat ghee in a pan and roast sorghum *rawa*, pearl millet flour and finger millet flour till nice aroma comes.
- Roast chopped dryfruits in ghee.
- Add cardamon powder and sugar powder to the roasted ingredients.
- Add warm milk or ghee and cook till all the mixture gathers together, make lemon size ball and serve.



A N N E X U R E - I

Nutritional Profile of Millets

The nutritional importance of sorghum and other millets cannot be underestimated. Regular millet consumption reduces the incidence of cardiovascular, gastrointestinal and lifestyle (diabetes) diseases. To popularize the millet consumption, it is important to understand the nutritional health benefits of millets. However the data on the nutritional composition of millets is scanty. Hence an attempt is made to compile brief grain structure and nutritional profile of different millets as describe below.

1. Structure of millet grain

The millet kernels differ from grain to grain but are mainly a covered or naked/utricule caryopsis and consists of three main anatomical parts, namely the, pericarp (outer layer), endosperm (storage tissue) and germ (embryo). In sorghum the proportion of these amounts about with their

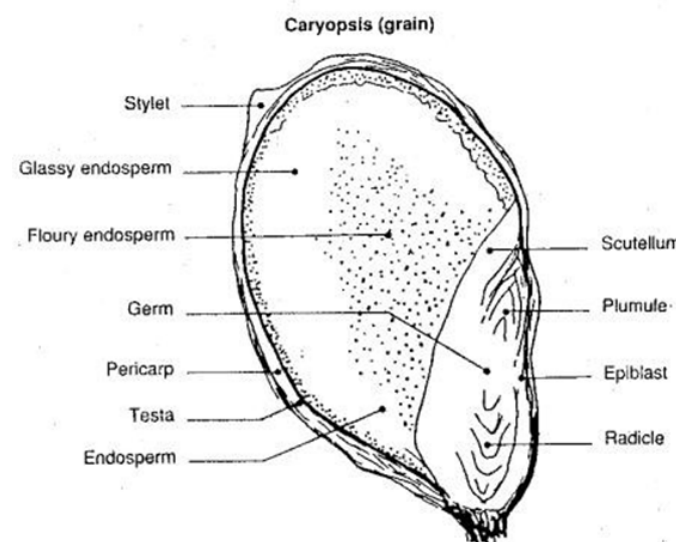


Fig. 1: Structure of Millet Grain (Eg. Sorghum)

Table 1 : Nutrient composition of millets compared to fine cereals (per 100 g)

Millets/Cereals	Carbo-hydrates(g)	Protein (g)	Fat (g)	Energy (Kcal)	Crude fibre (g)	Mineral matter (g)	Ca (mg)	P (mg)	Fe (mg)
Sorghum	72.6	10.4	1.9	349	1.6	1.6	25	222	4.1
Pearl millet	67.5	11.6	5	361	1.2	2.3	42	296	8
Finger millet	72	7.3	1.3	328	3.6	2.7	344	283	3.9
Foxtail millet	60.9	12.3	4.3	331	8	3.3	31	290	2.8
Proso millet	70.4	12.5	1.1	341	2.2	1.9	14	206	0.8
Kodo millet	65.9	8.3	1.4	309	9	2.6	27	188	0.5
Little millet	67	7.7	4.7	341	7.6	1.5	17	220	9.3
Barnyard millet	65.5	6.2	2.2	307	9.8	4.4	20	280	5
Rice (raw, milled)	78.2	6.8	0.5	345	0.2	0.6	10	160	0.7
Wheat (whole)	71.2	11.8	1.5	346	1.2	1.5	41	306	5.3

(Source: Nutritive Value of Indian Foods, NIN, Hyderabad, 2007)

seed mass at about 6%, 84%, and 10% respectively. However, the relative proportion of these components varies with relative proportions depending on the cultivars and environmental conditions. The outer layer or the pericarp originates from the ovary wall and is divided into three histochemical tissues: the epicarp, mesocarp and endocarp. Sorghum is the only cereal grain known to have starch in the mesocarp layer of pericarp.

The endosperm is composed of the aleuronic layer, the peripheral, corneous and floury areas. The corneous and floury endosperm cells are composed of starch granules, a protein matrix, protein bodies, and cell walls rich in cellulose, β -glucans, and hemicelluloses. Endosperm happens to be the main storage tissue. The starch granules are polygonal and often contain dents from the protein bodies. The size of starch granule varies from 4 μ m to 25 μ m. The proportion ratio of corneous to floury endosperm ratio determines the kernel texture in terms of grain hardness; the, higher the corneous portion, the harder will be the kernel and vice versa. The corneous portion will be translucent whereas the floury layer will be opaque. The aleuronic tissue is made up of thick cell walls and happens to be a rich source of protein, oil and minerals. The enzyme proteins are also mostly located in this tissue. The germ consists of the embryonic axis and, scutellum and it contains reserve nutrients and serves as the bridge or connecting tissue between the endosperm and germ. The embryo is a very good source of protein, minerals, oil and vitamins.

2 Chemical and nutritional composition of millet grain

The millet grain is rich in fiber and minerals has sufficient quantity of carbohydrates (60.9-72.6%), protein (6.22-11.6%) and fat (1.12-4.7%). Starch is the major constituent of the grain. The grain contains protein, albumin, globulin, prolamin and glutelin. Millets do not contain gluten and its slower hydrolysis makes it attractive to diabetics, celiac and ethnic groups. Particularly in developed countries, there is a growing demand for gluten free foods from people with celiac disease and other intolerance to wheat. Though millets nutritionally superior, its consumption has been decreased gradually due to the non- availability of processed clean grain in markets. To increase millet consumption among the urban population, development of processing technologies is a prerequisite. As a step towards this, under the NAIP project, IIMR has taken up the millet processing, and developed value added millet products. Around 30 machineries for different processes were procured and retrofitted.

Millets have unique nutrients value which is good for physical and mental health. They have high fibre content, low sugar, vitamins and vitamins and if consumed regularly they promote movement of the bowels, help detoxify the system, renders less blood sugar and cholesterol than eating fine flour or rice.

Table 2: Micronutrient profile of millets compared to fine cereals (mg/100g)

Cereals/Millets	Mg	Na	K	Cu	Mn	Mb	Zn	Cr	Si	Cl
Foxtail millet	81	4.6	250	1.40	0.60	0.070	2.4	0.030	171	37
Proso millet	153	8.2	113	1.60	0.60	-	1.4	0.020	157	19
Finger millet	137	11.0	408	0.47	5.49	0.102	2.3	0.028	160	44
Little millet	133	8.1	129	1.00	0.68	0.016	3.7	0.180	149	13
Barnyard millet	82	-	-	0.60	0.96	-	3	0.090	-	-
Kodo millet	147	4.6	144	1.60	1.10	-	0.7	0.020	136	11
Sorghum	171	7.3	131	0.46	0.78	0.039	1.6	0.008	54	44
Pearl millet	137	10.9	307	1.06	1.15	0.069	3.1	0.023	147	39
Rice	90	-	-	0.14	0.59	0.058	1.4	0.004	-	-
Wheat	138	17.1	284	0.68	2.29	0.051	2.7	0.012	128	47

Source: Nutritive value of Indian foods, National Institute of Nutrition (2007); MILLET in your Meals, <http://www.sahajasamrudha.org>

Table 3: Vitamin profile of millets and major cereals

Millets	Thiamin (mg)	Niacin (mg)	Riboflavin	Vitamin A (carotene) (mg/100g)	Vit B6 (mg/100g)	Folic Acid (mg/100g)	Vit B5 (mg/100g)	Vit E (mg/100g)
Foxtail millet	0.59	3.2	0.11	32	-	15	0.82	31
Proso millet	0.41	4.5	0.28	0	-	-	1.2	-
Finger millet	0.42	1.1	0.19	42	-	18.3	-	22
Little millet	0.3	3.2	0.09	0	-	9	-	-
Barnyard millet	0.33	4.2	0.1	0	-	-	-	-
Kodo millet	0.15	2	0.09	0	-	23.1	-	-
Sorghum	0.38	4.3	0.15	47	0.21	20	1.25	12
Pearl millet	0.38	2.8	0.21	132	-	45.5	1.09	19
Rice	0.41	4.3	0.04	0	-	8	-	-
Wheat	0.41	5.1	0.1	64	0.57	36.6	-	-

Source: Nutritive value of Indian foods, National Institute of Nutrition (2007); MILLET in your Meals, <http://www.sahajasamrudha.org>

The common element in all sectors of the food processing is conversion of raw material into a product of higher value. In some situations, processing is a one – step conversion of raw material to a consumer product. The history of food processing emphasizes the role of establishing and maintaining microbial safety in foods, as well as the desire to establish and maintain economic shelf-life for foods. All developments in food processing have similar and common origins. One common aspect is achieving and maintaining the microbial safety in the product. The processing methods are used worldwide as they improved digestibility and nutritional quality of the grains.

1. Overview of millet processing

Millet processing involves the partial separation and modification of the three major constituents of the millet grain – the germ, the starch containing endosperm and the protective pericarp. Various traditional methods of processing are still widely used, particularly in those parts of the semi – arid tropics where millet is grown primarily for human consumption.

Most traditional processing techniques are laborious, monotonous and manual. They are almost entirely left for women to do. To some extent, the methods that are used have been developed to make traditional foods to suit local tastes and are appropriate for these purposes. Traditional techniques that are commonly used include decortication (usually by pounding followed by winnowing or sometimes sifting), malting, fermentation, roasting, flaking and pounding. These methods are mostly labor intensive and give a poor – quality product.

Processing methods have been either fine – tuned or developed by IIMR using modern equipments to prepare

good quality of processed products like dehulled millet, semolina or *suji*, flakes, extruded products (vermicelli and pasta), biscuits, millet rich multi grain *roti* and millet rich multigrain flour to improve the nutritional quality as well as the consumer acceptability of millet grains. Food processing operations are undertaken to add value to food commodities after production. The main purpose of processing is to minimize the qualitative and quantitative deterioration of the material during post-harvest. The millet processing operations mainly involve:

a) Primary processing

Purification of raw materials by removing foreign matter, immature grain and making into the suitable form for secondary processing through grading, destoning and dehulling. The bulk operations of these processes can be done mechanically. Primary processing of the grain is removal of impurities, foreign contaminants and glumes from the grain that are necessary to improve the storage capacity of the grain and consumer acceptability for usage.

b) Secondary processing

Processing of primary processed raw material into product which is suitable for food uses or consumption such as Ready-To-Eat (RTE) and Ready-To-Cook (RTC) products, which minimize the cooking time and make it convenience foods. IIMR has developed, standardized millet based products such as multigrain *atta*, semolina (fine & medium), flakes, biscuits and cold extruded products (pasta & vermicelli) and commercialized sorghum based products.

2. Importance of processing intervention

Non-availability of RTE and RTC millet products in market contributes the consumption declination. This scenario was found to be proportional to the increase in production expenditure and increased income is accompanied by increased consumption of wheat and rice, as products made from these cereals are easy to prepare and have better keeping quality. At the same time, people have increased their tendency to eat a greater variety of foods. The prospects of technological change could perhaps change the scenario for improved production and utilization of millet.

One of the major constraints identified in developing variety of millet products is the drudgery in processing millet. Traditional processing method of hand pounding is not an efficient method because a part of the husk remains in the grain. Improperly dehusked grain cannot be ground to fine quality flour. Therefore, use of millets has been limited to traditional preparations like *roti* and rice. Absence of appropriate processing technologies to yield shelf stable products is a major limitation in utilization of millet grain for development of value added products. Urban consumers want food products that can deliver convenience, taste, texture, appealing appearance and shelf stability. Up scaling millet products that meet these requirements are usually not available in urban areas.

At IIMR an attempt has been made to make excellent prototype products from sorghum and millet with good processing quality. Taking due consideration of the present context, a renewed effort is made to create demand for millet through processing interventions by diversifying its food uses; integrating all functions from on-farm production to consumption in a ‘production to consumption value-chain. For this particular reason, IIMR took up the challenge to increase millets consumption, with special preference given to sorghum millets vis –a-vis its production.

3. Processing and value – added products from millets

Value addition in food processing has high degree of interdependence with forward and backward linkages and hence can play an important role accelerating economic development. Value addition has many consumer benefits such as simple, low-cost processing and packaging technologies which can improve the shelf life and storage quality of food and preserve many of the health promoting compounds.

For example in India, sorghum is mainly grown in the *rabi* or dry season, which produces white bold grain, which is free from blemishes. This grain is highly prized for processing. Sorghum grown in the *kharif* (wet season) has staining and molds that deteriorates quality of food. In this context, the IIMR had screened around 430 genotypes (germ-plasm lines, elite lines and released hybrids /varieties) for various physical and chemical parameters. Promising germplasm is being utilized in existing breeding programs to develop cultivars with superior grain quality. For food processing purposes, IIMR mostly procure grains of M 35-1, an improved cultivar from the participating farmers under the on-farm millet cultivation of the NAIP project.

4. Processing of millet grains

Processing involves the cleaning, grading, partial separation and/or modification of the three major constituents of the millet grain – -the germ, the starch-containing endosperm and the protective pericarp. Various traditional methods of processing are still widely used, particularly in those parts of the semi-arid tropics where millet is grown primarily for human consumption. Most of the traditional processing techniques are laborious, monotonous and manual.

At IIMR processing interventions in millet are attempted to remove the inconveniences in recipe making by developing and standardizing millet product technologies. For this purpose, the IIMR has installed and retrofitted machineries especially for sorghum grain.

Primary and secondary processing methods have been developed and fine-tuned using those equipments to prepare good quality of millet processed products like multi grain *atta*, semolina, flakes, extruded products (vermicelli and pasta) & biscuits to improve the nutritional quality as well as the consumer acceptability of millet with improved shelf life.

Processing interventions is continuing to include all millets at IIMR to target at niche market as well as for mass marketing at the national level. Improved packing material is used for all millet products. IIMR has developed & commercialized millet products under the brand of “*eatrite*” solely to widen the commercialization of millet in the country. Further products from millets are in verge of being commercialized under the same *eatrite* brand.

4.1 Cleaning and grading of millet grain

After harvesting, grains needs to be dried to have optimum moisture content to store the grains safely without deterioration. Cleaning, grading and destoning of the millets are very important aspect of primary processing before the grains are subjected to the dehulling/de-husking to make them free from dirt, dust, stones and unwanted foreign matters.



Fig. 2: Cleaner, destoner cum grader (sorghum/pearl millet)

Millet grain used to be cleaned manually and then milled but nowadays, while it may be cleaned as such at the household level, it is mostly done using a destoner machine.

The machine is integrated with:

- Aspirator
- Grader

Stones, metal pieces, glass, mud particles and other high-density impurities as well as straw, chaffs and such other low-density impurities are separated from millet in one operation. Even small and lightweight pebble of size of the grain can be separated, thus ensuring optimal cleaning.

4.2 Dehulling or pearling of millets

Dehulling is used to separate the anatomical parts of the grain as clearly as possible. This processing is necessary to remove mycotoxins on molded grain especially for *kharif* cultivars.

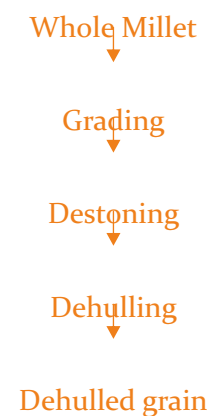


Fig. 3: Flow chart for dehulling of millet grain

4.2.1 Equipment used for millet dehulling

(1) Sorghum and pearl millet dehuller

Dehuller unit is used to remove the coarse outer layer of millets (10%), which has less effect, on nutritional quality. The breakage is nominal during dehulling. Fine flour produced from dehulled grain is used for the preparation of bakery foods, snack foods and instant mixes that resembles rice and wheat products in quality. Each millet has different dehuller machine as the seed coat varies for each millet. The unit for sorghum and pearl millet can dehull 10-15 kg grain per batch in 20 minutes.

The sorghum and pearl millet dehuller unit consists of

- Grain hopper,
- Abrasive stones,
- Inspection door,
- Discharging door and
- Husk outlet.

The grain is dropped in the feeder, enters the dehulled chamber where the grinding stones dehull the grain. Through the inspection door the grain can be checked for dehulling quality. Then the grain is released from discharging door which is at the bottom of the machine.



Fig. 4: Sorghum and pearl millet dehuller

(2) Small millet dehuller

The unit for small millet can continuously dehull upto 20-25 kg per hour grain per batch in 20 minutes.

The small millet destoner cum dehuller unit consists of

- Grain hopper,
- Centrifugal dome dehulling chamber
- Grain discharge,
- Husk outlet
- Aspirator and
- Grader

The grain is dropped in the feeder, enters the centrifugal dome dehulled chamber where the centrifugal rotating dome causes dehulling of the grain. Through grain outlet the grain is released which is graded through the grader at the bottom of the machine. The husk is removed through the husk outlet.



Fig. 5: Small millet destoner, grader cum dehuller

Table 4: Nutritional values of dehulled sorghum

S.no.	Nutrients (100g)	Amount
01	Energy (kcal)	349.0
02	Carbohydrates (g)	78.5
03	Protein (g)	8.6
04	Fat (g)	2.3
05	Riboflavin (mg)	0.02
06	Folic acid (mg)	2.2
07	Calcium (mg)	12.1
08	Iron (mg)	3.3
09	Zinc (mg)	0.9
10	Magnesium (mg)	82.1
11	Chromium (mg)	1.0

Source: IIMR study (2009-2010)

4.3 Milling of millets

Millets flour is made through milling technology. Milling is a process of separating the bran and germ from the starchy endosperm so that the endosperm can be ground into flour and *rawa* using different types of sieves in a hammer mill. The quality of the product was evaluated by preparing *roti* or other products. For example, millet semolina locally called as *rawa* or *suji* can be made in two forms with two different particle sizes, coarse 1.18 mm and fine 0.71 mm respectively. Both forms of *rawa* are commercially available in market. *Raw*a recovery ranges from 50-85% in case of coarse *rawa* and 40-75% in fine *rawa* and remaining 60-70% is flour. The recovery, however depends on the millet variety as well as the machinery used.

During milling process, there is a decrease in protein, riboflavin, zinc and calcium and an increase in carbohydrate and fat content.

Table 5. Nutritional values of sorghum flour and *rawa*

S.no.	Nutrients (100 g)	Flour	<i>Raw</i> a
01	Energy (kcal)	342.0	350.0
02	Carbohydrates (g)	75.0	77.8
03	Protein (g)	5.1	7.1
04	Fat (g)	2.4	1.2
05	Thiamin (mg)	2.3	-
06	Riboflavin (mg)	0.4	1.1
07	Folic acid (mg)	2.3	1.2
08	Calcium (mg)	10.0	5.8
09	Iron (mg)	8.4	5.1
10	Zinc (mg)	1.3	1.3
11	Magnesium (mg)	63.4	86.0

Source: IIMR (erst while DSR) study (2009-2010)

Pre-processing of millet grain to prepare *rawa*

As the millet grain undergoes pre-drying (sun drying) in the field after harvesting the grain is trodden by animals and dust, stones, adulterants and immature grains are present in the grain. Hence pre-processing of grain is to be done to ensure longer shelf life of the product made. Hence, to obtain that objective at IIMR the grain is cleaned properly and pre-processed, which increased shelf life from 2 months to 5 months for all the millet grain milled products. This is a process of soaking the millet grain overnight and drying till 21% moisture content and roasting for 1-2 minutes and then pulverising the grain to semolina. The preprocessing has been developed and standardized for preparation of *idli*, *upma* and *khichidi rawa* from sorghum grain, *idli rawa* for pearl millet, finger millet and foxtail millet.

4.3.1 Equipment used for milling millets

(1) Flour mill

Conventional flour mills have rotating blades (hammer/plate mill) or stones (*chakki* mill) which grind the grain in a grinding chamber and pass it through a screen which separates the flour from the larger, unground particles during rotation, the flour is carried through the screen in the mill.

Flour mill consists of

- Feed Hopper
- Adjustable feed gate
- Milling unit
- Product outlet

*Raw*a recovery ranges from 50-85% in case of coarse *rawa* and 40-75% in fine *rawa* and remaining 60-70% is flour. The recovery, however depends on the millet variety as well as the machinery used.



Fig. 6: Milling equipments (*chakki* mill & plate mill)

(2) Barbender junior equipment used for millet fine semolina

The unit removes 100% husk with breaking of grain into equal partials (fine *rawa*). The machine can produce 500 g of fine semolina in 5 minutes. Cost of the equipment is Rs. 16,00,000 and imported from Germany. The recovery of fine semolina is 92 percent.

Fine semolina making consists of

- Hopper,
- Adjustable feed gate,
- Round sifter
- Fine *rawa* drawer and
- Bran drawer.

After cleaning and preparation, the grain is filled into a lockable hopper with a maximum of 500g. From here, the grain flows through an adjustable feed gate from the feed roll to the first break roll and without intermediate sifting, to the second break roll. The second roll of the first break at the same acts as first roll of the second break. This principle is also used for grinding flour. After having passed the second break, the sample material goes directly to the "middling's reduction". Here, the second roll of the second break works against the roll with the finest corrugation of the semolina passage.

Due to the self-grinding effect of the grain particles, this closed milling process provides for perfect separation of the endosperm from the exosperm. Sifter analysis has shown that the bran is thus preserved from being crushed.

The sifted *rawa* drops into the *rawa* drawer below the sifter. The bran is collected in the bran drawer below the discharge of the sifter. The mill is factory-adjusted so that no re-adjustment is required when the type of millet grain or the moisture has changed.

Though millet has superior nutritional features, the consumption of this grain is limited due to non-availability of products which are easily prepared compared to rice and wheat products. Flour and semolina/*rawa* are products from which greater variety of foods can be prepared. The availability of semolina for the various millet preparations in the food markets is the other alternative for increasing millet consumption. The semolina prepared by IIMR resembles rice semolina in appearance and taste. Millet/sorghum semolina can be used for breakfast and snack food preparations replacing wheat and rice *rawa*.



Fig. 7: Fine semolina making machine (Barbender junior)

Table 6: Nutritional values of sorghum fine *rawa*

S.no.	Nutrients (100 g)	Amount
01	Energy (kcal)	353.0
02	Carbohydrates (g)	77.7
03	Protein (g)	6.6
04	Fat (g)	1.7
05	Thiamin (mg)	1.1
06	Riboflavin (mg)	2.1
07	Folic acid (mg)	2.5
08	Calcium (mg)	1.3
09	Iron (mg)	10.5
10	Zinc (mg)	1.2
11	Copper (mg)	35.0
12	Magnesium (mg)	76.5

Source: IIMR study (2009-2010)

4.4 Sorghum rich multigrain flour

Sorghum flour does not contain proteins that produce the viscoelastic gluten of wheat; therefore, acceptable yeast leavened products from 100% millet flour are difficult to obtain. However, sorghum flour in combination with other cereal grains such as wheat, finger millet, black gram *dal* / bengal gram/ soya and fenugreek (*methi*) adds gluten to the produce. The level of millet substituted for wheat flour depends on the strength and quality of gluten in the wheat flour; the packing procedure; the definition of acceptable bread quality; the colour, particle size and shape of millet flour. The particle size and shape of millet flour often increase the grittiness of the baked products; however, tampering, attrition, milling, and other modifications during processing can modify the sandiness of the flour.

4.4.1 Composition of millet rich multigrain flour

Multigrain flour is made from blended flours of cereals (millet, wheat), finger millet and pearl millet (*bajra*) along with soy-bean, a protein rich pulse. Such food meets the emerging nutritional needs of the people in the wake of preferences for modern and healthy food habits for mass feeding and social programme. While different grains have varied advantages, millet and other millets add minerals, dietary fiber and nutrients which are otherwise inadequate in normal roti made from wheat. Soya bean is a rich source of protein, and hence the mixer is based on health-promoting constituents. Addition of wheat to the dough makes it pliable and allows better shaping, retaining the original.

Table 7: Nutritional composition of sorghum rich multigrain flour

S.no.	Nutrients (100 g)	Amount
01	Energy (Kcal)	339.0
02	Carbohydrates (g)	68.7
03	Protein (g)	8.8
04	Fat (g)	3.2
05	Thiamin (mg)	0.3
06	Niacin (mg)	1.9
07	Riboflavin (mg)	0.1
08	Folic acid (mg)	0.9
09	Calcium (mg)	15.4
10	Iron (mg)	3.5
11	Zinc (mg)	1.7
12	Magnesium (mg)	140.2

Source: IIMR study (2009-2010)

4.4.2 Equipment for *roti* making

(1) Automatic *roti* making machine

Currently, a small electrical *roti* making machinery is available in the market for ready to prepare *rotis*. This machinery helps to bake the *roti* but not to prepare the *roti*. The *roti* has to be done separately by roller. This type of *roti* making machinery is confined to home purpose only.

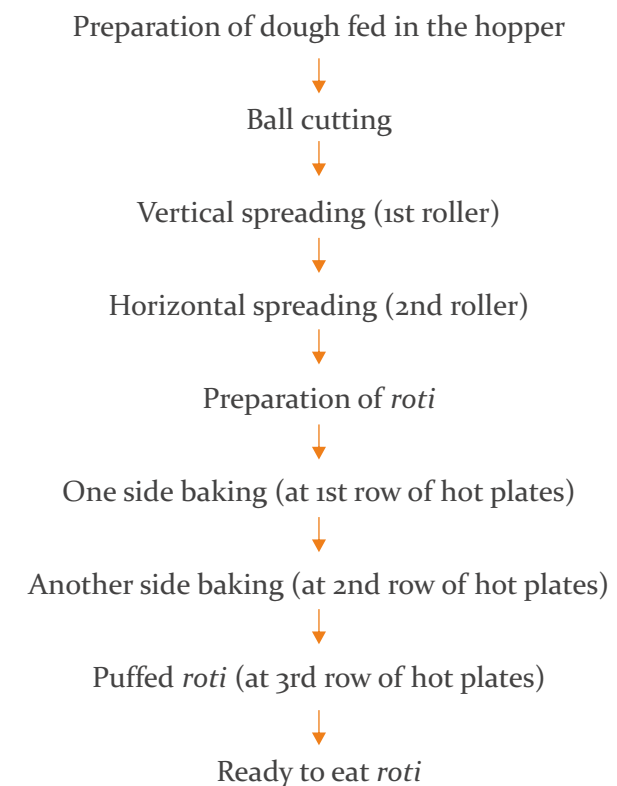


Fig. 8 Process flow diagram for preparation *roti* from *roti* making machine

Table 8: Nutritional values of sorghum multi grain *roti*

S.no.	Nutrients (100 g)	Amount
01	Energy (kcal)	327.0
02	Carbohydrates (g)	66.3
03	Protein (g)	5.0
04	Fat (g)	4.6
05	Thiamin (mg)	0.6
06	Calcium (mg)	16.2
07	Iron (mg)	6.0
08	Zinc (mg)	0.5

Source: IIMR study (2009-2010)

The automatic *roti* making machine completes the preparation of *roti* starting from making dough ball to ready to eat *roti* form. The capacity of automatic *roti* making machine is 1500 -2000 *rotis* per hour. Average size *rotis* of 36 per kg flour can be prepared in this machine.

Automatic *roti* making machine consists of

- Starter point,
- Dough hopper / feeder (dough is prepared manually),
- Ball cutter with size adjuster, pressing and sheeting rollers and
- 3 rows of hot plates with each set point temperatures
- Before feeding the dough in hopper, the machine is

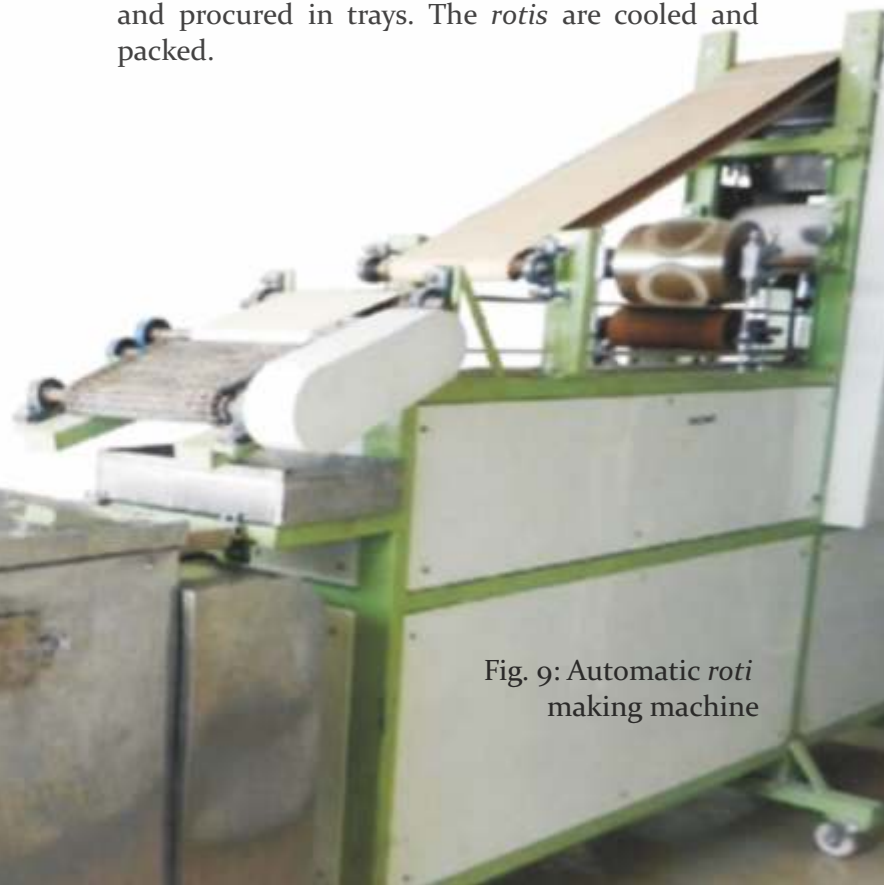


Fig. 9: Automatic *roti* making machine

pre run for 15 minutes that is till the 1 and 2 row of hot plates reach the set point temperature.

- The set point temperature for 1 row is 190°C to 200°C whereas 140°C to 150°C for the 2 row.

There is no set point temperature for 3 row of hot plates. The description of each step in preparation of *roti* is given below:

1. Dough preparation: Dough is prepared manually with single flour or combination of flours. The dough should be kneaded well and should be soft.
2. Ball cutting: The kneaded dough is fed in the hopper. The ball cutter cuts the dough into desirable ball size and passes on to belts. As the balls pass through the belts the rollers and pressing sheets spread the dough into *roti* shape. The pre-prepared *roti* is transferred to 3 rows of hot plates serially where *rotis* are baked on both sides and puffed.
3. Finally ready to use *roti* form comes through outlet and procured in trays. The *rotis* are cooled and packed.

(2) Millet *roti*-making machines

Jointly developed by IIMR in association with private entrepreneur

Advantages and uniqueness of the *roti* machine

- Used to make gluten-free *roti* conveniently with higher capacity.
- Removal of inconveniences in preparation of sorghum/millet based *rotis*.

Features	Version 1	Version 2	Version 3	Version 4
Operation by	Foot	Hand	Hand	Hand
Space Required	More	Less	Less	Very Less
Capacity(<i>rotis</i> per/hr)	40	50-60	80-100	50-60
Speed (RPM)	Low (150)	Medium (200 rpm)	High (250 rpm)	Medium (200 rpm)
Cost	Rs 25 K	Rs 12 K	Rs 10 K	Rs 7 K



Version - 1



Version - 2



Version - 3



Version - 4

Fig. 10: Millet *roti* making machines

4.5 Flaking of sorghum / millet grain

Flakes are popular snack food and have been widely produced for centuries. Rice flakes are produced and consumed throughout the world. Sorghum is a coarse grain and is difficult to pound. However, with the advent of technology, Edge runner (flaking machine) along with roaster has made it possible to produce flakes from sorghum. Sorghum flakes produced from the flaking machine resembles rice flakes and output is 50-60%.

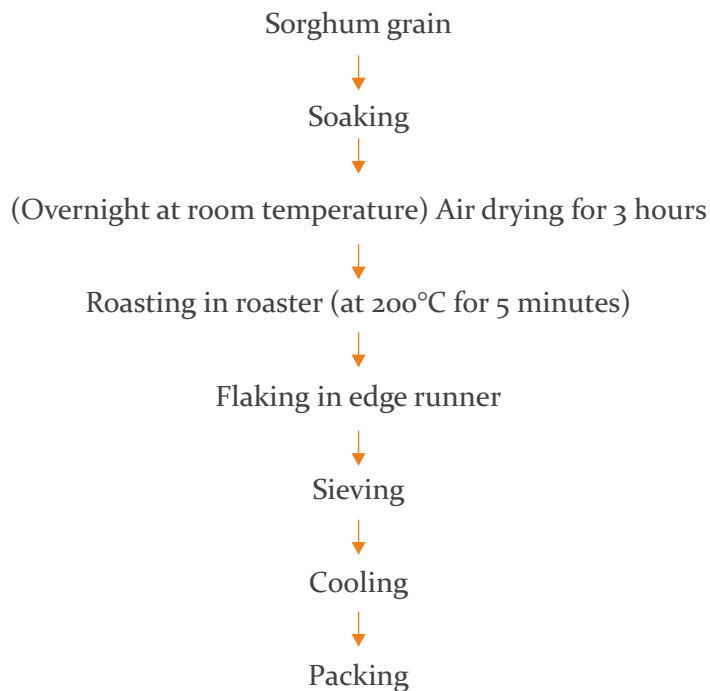


Fig. 11: Flow diagram for the preparation of millet flakes using edge runner

Table 9: Nutritional composition of sorghum flakes

S.no.	Nutrients (100 g)	Amount
01	Energy (kcal)	340.0
02	Carbohydrates (g)	79.7
03	Protein (g)	7.2
04	Fat (g)	1.8
05	Thiamin (mg)	0.4
06	Riboflavin (mg)	1.1
07	Niacin (mg)	1.9
08	Folic acid (mg)	1.6
09	Calcium (mg)	10.9
10	Iron (mg)	3.4
11	Zinc (mg)	0.8
12	Magnesium (mg)	68.9

Source: National Institute of Nutrition (2010-2011)

4.5.1 Equipment used for the preparation of sorghum flakes

(1) Roaster

The roaster consists of circular tank which contains heat coils and feed hopper on top. The set temperature point is fixed to the machine. The roaster is preheated to 190 - 200 C before the grain is roasted. The grain dropped in the hopper enters the tank where grain is precooked and softened. The unit holds 3-5 kg grain per batch.



Fig. 12: Grain roaster

(2) Edge runner

The edge runner consists of flat circular rotator stone that presses the grain into flakes and supporter to control the grain while running the machine. The edge runner is run by 3HP motor. After roasting, the grain is transferred to edge runner where the roasted grain is pressed into flakes.

The capacity of edge runner per batch is 2kg. The whole process of roasting and flaking takes 3 minutes per batch (3-5 kg). Both the machinery can run for 8 hours basis daily without disruption.

The machinery would cost Rs 3.0 lakhs. There is choice of fuel viz firewood, diesel, electricity and gas and the price of roaster de-pends on the fuel compatibility.



Fig. 13: Edge runner

4.6 Millet Biscuits

The biscuit making machine consist of planetary mixture, cutting machine and convection oven. In preparation of biscuits, to reduce the drudgery, enhance biscuit quality and hygiene good manufacturing practices must be followed

4.6.1. Equipments used for making millet biscuits

(1) Planetary mixer

Planetary mixer consists of

- Kettle
- 2 blades (centre blade and edge blade)
- Kettle shifter.
- Speed adjuster and height adjuster of blades.
- The capacity of the kneader is 12 kg per batch. The picture of dough kneader is shown in Fig 30.



Fig. 14: Planetary mixer

(2) Biscuit cutting machine

Biscuit cutting machine consists of

- Hopper, in which sheeting rollers are inserted and beneath the rollers cutting dies are fitted. The function of the sheeting rollers is to spread the dough into biscuit shape.
- The capacity of machine is 5-7 kg per batch



Fig. 15: Biscuit cutting machine

(3) Rotary Oven

The technology 'rotary oven' is a worthy advancement over convection oven. In the conventional oven, the warmest air is not equally distributed and thus food at bottom tray/top tray than the food at centre racks. A rotary oven uses a built in fan which is located on the backside also trays are rotated. The purpose of the fan is to force the heated air faster inside the oven through the cavity and circulate it around the item being cooked. The heated air is constantly pushed over and around the food, and therefore a rotary oven cooks much faster than a convection oven.

Rotary oven not only cooks food more quickly than a rotary oven but it can also thoroughly cook food at lower temperatures. The average amount of time saved when cooking with a rotary oven is about 20 percent when compared to foods normal cooking time. The temperature as it uses to cook food is also about 20% lower than recipes suggested cooking temperature. The rotary oven cooks food more evenly and burns less frequently.



Fig. 16: Rotary oven

The rotary oven consists of the following components

- A cabin with racks
- Trays
- Oven cavity
- Starter with temperature indicator

A rotary oven can be filled from top to bottom as long as an inch of space is left for the air to circulate the oven walls. Also, since the air circulation in rotary oven is the same throughout, food will cook at the same rate no matter where ever it is placed. Ovens are expensive compared to traditional ovens as these units offer tremendous advantages over non convection ovens. The cost of oven is Rs.5,00,000/-. On average 2500-3000 biscuits can be baked in convection oven evenly in 20 minutes at 150°C.

Table 10: Nutritional composition of sorghum biscuits

S.no.	Nutrients (100 g)	Amount
01	Energy (kcal)	481.0
02	Carbohydrates (g)	64.6
03	Protein (g)	7.7
04	Fat (g)	23.7
05	Thiamin (mg)	0.2
06	Riboflavin (mg)	0.2
07	niacin (mg)	1.9
08	Folic acid (mg)	0.5
09	Calcium (mg)	68.8
10	Iron (mg)	2.0
11	Zinc (mg)	1.7
12	Magnesium (mg)	92.2

Source: IIMR study (2009-2010)

4.7 Millet extruded products

Extruded products are ready -to-cook products which usually include vermicelli and pasta. The products are made with millet/sorghum flour or combinations of millet flour and semolina. There are two types of extruders in use: cold extruder and hot extruder. Hot extruder is more popular, and is used for making snack items (Ready-to-Eat) like *kurkure*. At the same time ready to cook products are also becoming popular in urban areas which requires less time for cooking. To manufacture pasta and vermicelli, cold extruder machine can be used The cost of machine is Rs.11,00,000. Capacity of machine is 12kgs per hour.



Fig. 17: Cold extruder

4.7.1 Equipment used for millet extruded products

(1) Cold extruder

The machine structure is made entirely of pure and unalterable stainless steel. The main components of machine are

- Upper tank motor and mixing shaft
- Automatic dough cutter with speed variator and stainless-steel blades
- Cooling blower for drying the product quality
- Stainless steel trolley on wheels

Dough plates come in two types for obtaining different dough Shapes. The first type (in bronze) produces rough textured dough with a duller surface. The second (in teflon) yields smoother dough with a shinier surface. The teflon dough plate is more delicate than the bronze one and enables a slightly higher hourly production of dough.

Mix for a bit longer, if the dough does not form little balls but remains very floury, add a little more liquid. The mixing shaft will start preparing the mixture. The dough will be ready to be extruded in 15 minutes. The dough must be friable and broken into granules. While the mixture is being kneaded in the lower tank, the upper tank is used for a new mixture. This makes it possible to knead without interruption, avoiding dead time and consequently increasing *macaroni* products.

Weighing millet semolina and wheat semolina

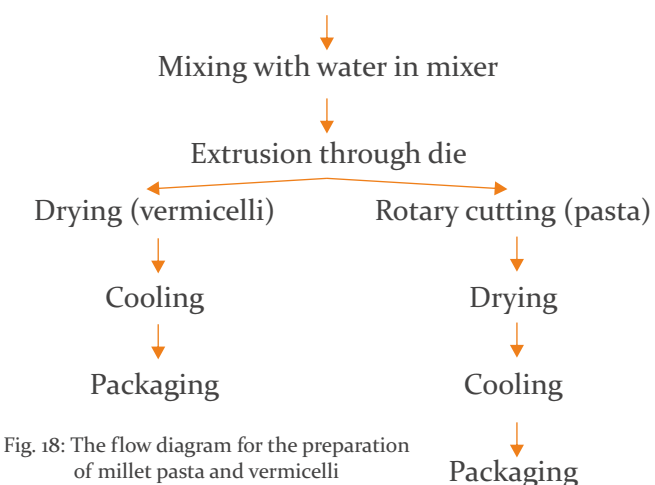


Fig. 18: The flow diagram for the preparation of millet pasta and vermicelli

The procedure for extrusion of millet vermicelli and pasta

The procedure of millet pasta/vermicelli preparation consists of adding water to the semolina made from whole millet and *maida* to make homogenous mass. The mass is then placed in extruder and moved towards the lower end of which is fitted with a disc perforated with openings and the mix is forced through openings. Pasta is available in different shapes and sizes by fixing special dies to the extruder.

(2) Hot extruder

In food processing has extrusion combines heating with the act of extrusion to create a shaped cooked product. Extrusion is accomplished by single screw and twin screw extruders. Commercially most of the extruded snacks are prepared from corn; here the extruded snack is made from millet grits, rice flour and soya flour.

The main components of hot extruder are

- Mixing chamber
- Feed hopper
- Heating barrel with twin screws
- Pressure transducer with dies
- Cutting plates

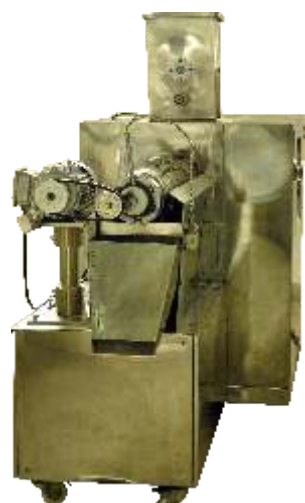


Fig. 19: Hot Extruder

The procedure for hot extrusion of millet extruded snacks

The mixture is combined and passes through twin screw extruder to produce expanded snacks which are ready to eat. The snack can be coated with desired spices to create variations in the taste and flavor. They can also be extruded in a single extruder without puffing and can be dried and coated with variety of spices and flavours.

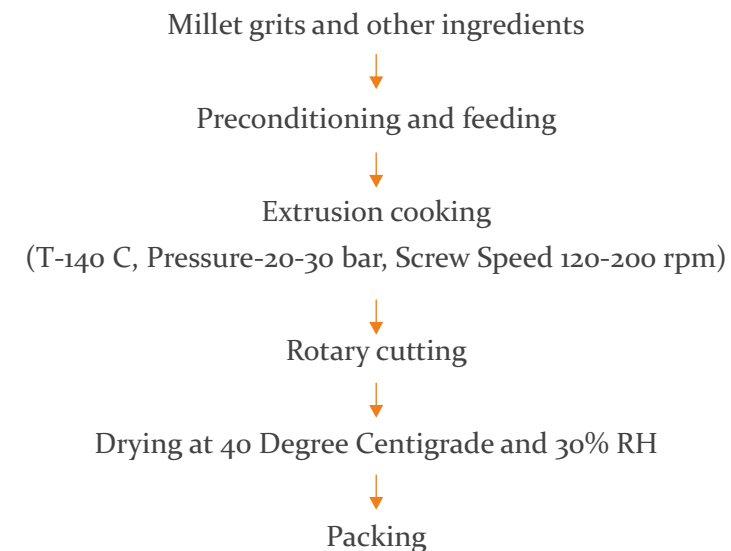


Fig. 20: Flow chart for the preparation of extruded snacks

Extruded products are digested slowly, as, its dense structure impedes enzymatic hydrolysis which is why it is suitable for diabetics. Children who like pasta products can be given millet pasta. It is an ideal meal for people who pay more attention to their dietary intake. In addition, people are finding less time to prepare product and ready cook and ready to eat extruded products give convenience options to the consumer.

Table 11: Nutritional composition of Sorghum vermicelli and pasta

S.no.	Nutrients (100 g)	Value
01	Protein (g)	8.4
02	Fat (g)	1.4
03	Carbohydrates (g)	76.2
04	Thiamine (mg)	0.7
05	Riboflavin (mg)	1.3
06	Calcium (mg)	6.4
08	Iron (mg)	6.4
09	Zinc (mg)	0.7
10	Magnesium (mg)	67.5
11	Energy (Kcal)	355.0

All millet products generally have strong acceptability by the consumers. These products have more nutritional value and health benefits when compared to similar products developed from wheat and rice. Moreover these value added products are not easily available in the market. Efforts can be made to popularize millet products, low cost, high protein and energy rich products among population through on-going nutritional intervention programs, development and consumption of such value added food claiming health benefits could go a long way in improving the nutritional status of the population especially those suffering from protein malnutrition and other deficiencies and diseases.

The preparation and production of such products at home and at commercial level would imitate the production units and small scale units in rural and urban areas to raise the income level of households. The manufacture of millet

value added products will help to upgrade not only the health status of the consumers but also the economic status of growers.

Despite the fact that consumption of millet as direct food use is declining, market for processed foods such as multigrain flour, flakes, vermicelli, pasta and biscuit is surprisingly picking up in urban areas as there is increasing acceptability of millet if available in ready-to-eat form or as convenient foods as health and nutritional foods. In this context of increasing demand for millet. Value-addition has acquired a great importance which will have a striking impact on socioconditions of dry-land farms.

Industrial linkages for expansion, marketing and commercialization by brand promotion of these food products will secure stable and profitable market for millets. These well developed value added, baked, supplementary healthy foods are recognized as ready to eat as well as cost effective and permeated in to the present day urban society. With the addition of being healthy and nutritionally superior and feasibility for large scale manufacturing with retrofitting of machinery, medium and large scale industries will come forward for the much needed commercialization and brand creation. Publication of this nature will create awareness among the entrepreneurs and industry about the technical know how of the processing and product development to envision the objectives of “eat rite and stay healthy”.

Agri Business Incubation (ABI)

The Agribusiness Incubator (ABI) has been established in 2016 at ICAR- IIMR, Hyderabad as a part of Indian Council of Agricultural Research ICAR's initiative of establishing 27 Agri Business Incubation (ABI) centers, under National Agricultural Innovation Fund (NAIF). across the country in various ICAR institutes. which were granted on competitive Programme mode. This concept promotes the growth through innovation, and applications of technology, support, economic development strategies for Small Business Development. ABI will play a role to create successful, viable and free standing business within a certain time frame. The broad objective of ABI is to promote knowledge-based and innovation driven millets based enterprises.

Our Vision

To provide and create a congenial situation for potential entrepreneurs and graduating startups so as to transfer knowledge and innovations into creation of successful entrepreneurs in millets processing, value addition and commercialization.

Our Mission

To create an environment that will foster the entrepreneurial spirit among women and youth through consultancy, research, training, promotion and incubation in high-tech technologies or ideas thereby promoting innovation and knowledge-based entrepreneurship in processing and value addition of millets leading to the self-employment, creation of wealth and social values.

WHAT WE DO.....

- Entrepreneurship/start up Awareness Camps at several venues across the country.
- Entrepreneurship Development programmes in millets.
- Provides specialized services to existing SMEs in the region.
- Various training programmes to boost and motivate the would-be entrepreneurs.
- Incubation of start-up ventures and mentoring.

For more details, kindly contact

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