TECHNOLOGIES OF MILLET VALUE ADDED PRODUCTS

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VALUE CHAIN ON MILLETS

Eat Millets - Stay Healthy

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FOREWORD

Dr. T. Mohapatra
Secretary DARE & Director General,
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MILLETS are traditionallygrown in resource poor agro climatic regions of the country which include sorghum, pearl millet, finger millet and small millets. 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, minerals such as calcium, iron, zinc, potassium and magnesium. In the present scenario, demand for millets for direct consumption has been declining due to change in food habits and inconvenience attached with food preparation as compared fine cereals.Further, lack of processing technologies and also the government policies of disincentives towards millets and favoring of supply of fine cereals at subsidized prices. The consumption of these food items has also been traditionally restricted mainly to growing areas. Millets are known for nutria-rich content and having characteristics like drought tolerance and resilient to climate change etc.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), (erstwhile DSR) has taken up the millet processing, and developed value added sorghum/milletfood products.

I am glad to know that the publication “Technologies of Millet Value Added Food Products” is being brought out by IIMR is a compilation ofall the technologies developed by Centre of Excellence (CoE) on sorghum, ICAR-IIMR, Hyderabad. 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. This handy book will surely benefit to the would-be entrepreneurs to initiate business on millets processing.

I congratulate ICAR-IIMR in bringing out this publication forcreation of demand of 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 and nutritional parameters for households, entrepreneurs and other stakeholders alike. I wish a very all the best to promote millets as health foods.

T. Mohapatra

Director General, ICAR

Dr. Vilas .A Tonapi
Director ICAR - IIMR

PREFACE

Millet crops primarily constitute a diverse group of small grains. These are categorized under Coarse Cereals in India. Millets are classified into major millets and minor millets or small millets. Millets are important crops for dryland farmers; they are highly nutritious and are a climate-compliant crop. But due to drudgery in preparation, overall millet consumption in India has declined over the years. In order to revive the demand of millets in India, there is need to bring all the stakeholders in production to consumption system value chain. The ICAR-IIMR (formerly DSR) has made attempts to innovate technologies that enable in developing sorghum/millet based value added products through NAIP subproject, 'Creation of Demand through PCS Millets Value Chain'.

In view of decreasing millets consumption, efforts have been made to integrate all the stakeholders to bring them on a common platform so as to create demand for millet cultivation which is popularly known as value chain mode from ICAR- IIMR. 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 (erstwhile DSR) launched its brand name "Eatrite" to the Indian markets to promote the millet based products and this book gives details of millets technologies developed at Centre of Excellence (CoE) on Sorghum under NFSM project of Department of Agriculture.

This book comprehensively deals with the millet based value addition technologies developed and commercialized from the Centre of Excellence (CoE), ICAR-IIMR. This resourceful publication act as a reference book for the all the millets stakeholders including would-be entrepreneurs who initiate millets based processing units. Eventually, I congratulate Dr. B. Dayakar Rao, Principal Scientist and his team for bringing out this book and appreciate the efforts they have put in the process.

Tonapi VA

Director, ICAR - IIMR

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EATRITE PRODUCTS TO BE COMMERCIALIZED

Fig. 1, Sorghum Puffs

Sorghum Grain
↓
Grading
↓
Dehulling
↓
Dehulled grain
↓
Conditioning
↓
water
↓
Gun puffing
↓
Sorghum puffs

Fig. 2, Process flow chart for production of Sorghum puff products

1. PUFFS FROM SORGHUM

Description of the technology

Sorghum puffs are product which is a resultant of explosive puffing or gun puffing where the sorghum grain is expanded to maximum expansion consistent with the grain identity (similar shape of the grain).

It is the RTE (ready to eat) snack which is developed using puff gun machine.

The puff gun machine is loaded with dehulled sorghum grain onto a rotating barrel and the mixture is roasted for and fired resulting in a puffed sorghum product.

Products and by products

- Puffs yield – 94%; By-product yield – 6% (small puffs and unpuffed grains)

Advantages and Uniqueness of technology/Product

- The sorghum puffs are white in colour and are crispy in nature, similar to the puffed rice.
- The shelf life is for 4 months when packed in air tight MET pouches at ambient temperatures.
- They are rich in protein and fibre.
- Variants available masala coated and fried, and also can be coated with other flours (bajra and channadhal) and fried.
- It can serve as inflight snack or generic evening snack

Nutrient composition for puffed sorghum (per 100 g)

NUTRIENTS (100 g)	VALUE
Protein (%)	11.9
Fat (%)	3.02
Dietary fibre (g)	13.88

2. PUFFS FROM FOXTAIL MILLET

Description of the technology

Foxtail puffs are product which is a resultant of explosive puffing or gun puffing where the foxtail grain is expanded to maximum expansion consistent with the grain identity (similar shape of the grain).

It is the RTE (ready to eat) snack which is developed using puff gun machine.

The puff gun machine is loaded with dehulled foxtail grain onto a rotating barrel and the mixture is roasted for and fired resulting in a puffed sorghum product.

Products and by products

- Puffs yield – 92%; By-product yield – 82% (small puffs and unpuffed grains)

Advantages andUniqueness of technology/Product

- The foxtail puffs are white in colour and are crispy in nature, similar to the puffed rice.
- The shelf life is for 2 months when packed in air tight MET pouches at ambient temperatures and study is still in progress.
- They are rich in protein and fibre.
- Variants available masala coated and fried
- It can serve as inflight snack or generic evening snack

Fig. 3, Foxtail Puffs

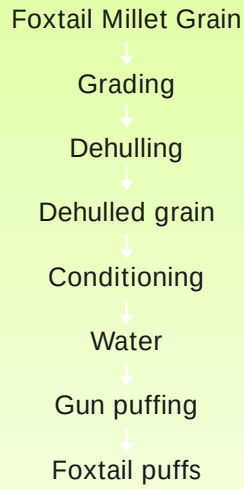

Fig. 4. Process flow chart for production of Foxtail Puff products

Fig. 5, Bajra Puffs

Whole Bajra
↓
Grading
↓
Parboiling
↓
Dehulling
↓
Conditioning
↓
Gun puffing
↓
Bajra puffs

Fig. 6, Process flow chart for production of Bajra Puff products

3. PUFFS FROM PEARL MILLET

Description of the technology

Pearl Millet (bajra) puffs are product which is a resultant of explosive puffing or gun puffing where the bajra grain is expanded to maximum expansion consistent with the grain identity (similar shape of the grain).

It is the RTE (ready to eat) snack which is developed using puff gun machine.

The puff gun machine is loaded with bajra grain onto a rotating barrel and the mixture is roasted for and fired resulting in a puffed sorghum product.

Products and by products

- Puffs yield – 44%; By-product yield – 56% (small puffs and unpuffed grains) (Standardization is still in progress)

Advantages andUniqueness of technology/Product

- The bajra puffs are greenish - creamy in colour and are crispy in nature.
- The shelf life is for 3 weeks months when packed in sir tight MET pouches at ambient temperatures, shelf life studies are in progress
- Variants available roasted, masala coated and fried
- It can serve as inflight snack or generic evening snack

4. EXTRUDED SNACKS

Description of the technology

Extruded Snacks are Ready-To-Eat products prepared using twin-screw hot extruder which combines heating with the act of extrusion to create a shaped cooked product through a round, minus shaped dies.

Commercially most of the extruded snacks are prepared from corn; here the extruded snack is made from sorghum grits, rice, ragi, wheat and corn flour. The mixture is combined and passed 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.

Products and by products

- Snacks yield – 90%; By-product yield – 10% (Extrudate by-product)

Advantages and Uniqueness of technology/Product

- The snacks vary in colour from white to cream and are crispy in nature
- Utility as evening snacks and inflight snacks.
- They are rich in protein, fibre, iron, zinc and magnesium.
- The shelf life of the product was 6 months and the shelf life analyses are still in progress.
- Variants available masala coated.

Nutritive values of ready-to-eat extruded snack per 100 g

NUTRIENTS (100 g)	VALUE
Protein (%)	12.90
Fat (%)	1.70
Dietary fibre (g)	12.88

Fig 7, Extruded Snacks

Fig. 8, Process flow chart for production of ready-to-eat (Extruded snacks) products

Fig. 9, Extruded Flakes

Sorghum, Wheat, Corn
↓
Conditioning
↓
add water
↓
Mixing
↓
Extrusion
↓
Roller flaking
↓
Extruded flakes
↓
Packaging

Fig. 10, Process flow chart for production of Extruded flakes products

5. EXTRUDED FLAKES

Description of the technology

Extruded Flakes are Ready-To-Eat products prepared using twin-screw hot extruder which combines heating with the act of extrusion to create round shaped product which is further flattened in roller flaker machine.

The extruded Flakes is made from sorghum grits, wheat and corn flour. The snack can be coated with desired spices to create variations in the taste and flavor.

Semolina (Sorghum: Wheat: Corn Flour) → Conditioning
Water → Extrusion → Roller flaker machine
Extruded flakes → Packaging

Products and by products

- Flakes yield – 88%; By-product yield – 12% (Extrudate by-product, un-flattened flakes)

Advantages and Uniqueness of technology/Product

- Utility as breakfast cereals and can be used instead of corn flakes.
- The shelf life of the product was 5 months and the shelf life analyses are still in progress.
- Variants available masala coated, chocolate or essence based

Nutritive values of ready-to-eat extruded flakes(per 100 g)

NUTRIENTS (100 g)	VALUE
Protein (%)	13.90
Fat (%)	1.40
Dietary fibre (g)	14.88

6. INSTANT MIXES

In the modern days where the life is at fast pace with the time very valuable to every person, "Instant Foods" play an important role in everyone's day-to-day life.

Instant and ready to reconstitute foods have become well established products in western countries. It is the need of the hour to develop traditional foods as convenience foods and IIMR has carried out research in developing sorghum based instant mixes described, here under.

A) INSTANT SORGHUM IDLI MIX

Description of the technology

Idliis an indigenous traditional breakfast food in mostly southern Indian cuisine, which is a steamed product made from rice semolina and ground pulses and typically served with a spiced vegetable filling or chutney.

We have made an attempt to prepare instant sorghum idli mix sorghum fine semolina, blackgram dhal, salt and food grade additives; citric acid and sodium bicarbonate were used as main ingredients.

All the ingredients were mixed uniformly in a blender. The formulated mix was packed in a MPET packing material.

Advantages and Uniqueness of technology/Product

- Instantly sorghum idli can be prepared reducing the cumbersome time for fermentation.
- It is rich source of phenolic compounds and causes satiety resulting in slower digestibility.
- Reduces oxidative stress (Antioxidant)
- The shelf life of idli mix is 3 months.
- The instant idli mix has high amount of calcium, iron, zinc and riboflavin when compared to control idli.

Fig.11, Instant Sorghum Idli Mix

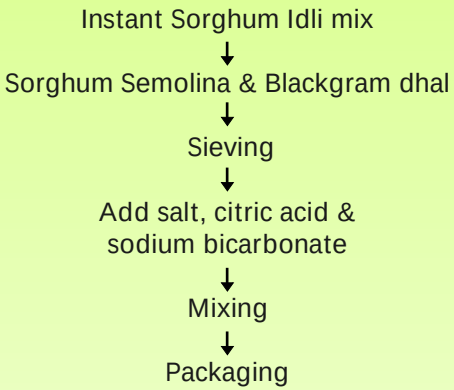

Fig. 12, Process flow chart for production of Instant Idli Mix

Nutritional Composition of Instant Idli 100 g.

Nutrients (100g)	Value
Energy (kcal)	364
Carbohydrates (g)	71.7
Protein (g)	12.4
Fat (g)	1.6
Riboflavin (mg)	1.5
Folic acid (µg)	45.7
Calcium (mg)	10.2
Iron (mg)	7.2
Zinc (mg)	0.9
Magnesium (mg)	102.3

Fig. 13, Instant Upma Mix

Sorghum Semolina
↓
Sieving
↓
Add mustard seed & bengal gram dal
↓
Roasting
↓
Add dried curry leaves & green chillies
↓
Add Salt
↓
Mixing
↓
Packaging

Fig. 14, Process flow chart for production of Instant Upma Mix

B) INSTANT UPMA MIX

Description of the technology

Upma is an indigenous traditional breakfast food in mostly southern Indian cuisine, which is boiled semolina made from wheat/rice with added pulses, condiments and spices.

We have made an attempt to prepare instant sorghum upma mix sorghum semolina, Bengal gram dal; mustard seeds, curry leaves, dried green chillies, salt, and oil were used as ingredients.

Semolina, mustard seeds and Bengal gram dal were roasted separately. To the semolina, roasted mustard seeds, Bengal gram dal, dehydrated curry leaves, salt and were added and mixed.

The formulated mix was packed in a MPET packing material.

Advantages and Uniqueness of technology/Product

- Instantly sorghum upma can be prepared with added flavor and taste.
- It is Gluten Free and safe for Celiac Patients.
- Rich source of phenolic compounds andcauses satiety resulting in slowerdigestibility.
- Reduces oxidative stress (Antioxidant)
- Low calorie diet (through Dietary fibre) promotes healthy digestion
- The shelf life of upma mix is 6 months.
- The instant upma mix has high amount of fibre, protein and iron when compared to control traditional upma.

Nutritional Composition of Instant Upma Mix (per 100 g.)

Nutrients (100 g)	Value
Energy (kcal)	374
Carbohydrates (g)	78.7
Protein (g)	13.4
Fat (g)	1.8
Fibre (g)	1.5

C) INSTANT DOSA MIX

Description of the technology

Dosais an indigenous traditional breakfast food in mostly southern Indian cuisine, which is a pancake made from rice semolina and ground pulses and typically served with a spiced vegetable filling or chutney.

We have made an attempt to prepare instant sorghum dosa mix sorghum flour, blackgram dhal (2:1), salt; citric acid and sodium bicarbonate were used as main ingredients and mixed uniformly in a blender.

The formulated mix was packed in a MPET packing material.

Advantages and Uniqueness of technology/Product

- Instantly sorghum dosa can be prepared with added flavor and taste.
- It is Gluten Free and safe for Celiac Patients.
- Rich source of phenolic compounds and causes satiety resulting in slower digestibility.
- Reduces oxidative stress (Antioxidant)
- Low calorie diet (through Dietary fibre) promotes healthy digestion.
- The shelf life of dosa mix is 6 months.
- The instant dosa mix has high amount of fibre and protein when compared to traditional dosa.

Nutritional Composition of Instant Dosa Mix (per 100 g.)

Nutrients (100 g)	Value
Energy (kcal)	364
Carbohydrates (g)	71.7
Protein (g)	12.4
Fat (g)	1.9
Riboflavin (mg)	1.5
Folic acid (µg)	45.7
Calcium (mg)	10.2
Iron (mg)	7.2
Zinc (mg)	0.9
Magnesium (mg)	102.3

Fig. 15, Instant Dosa Mix

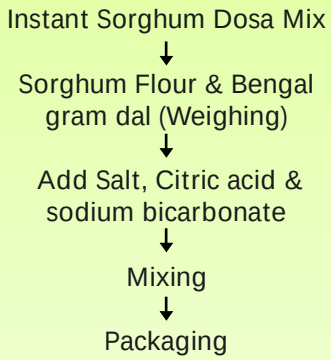

Fig. 16, Process flow chart for production of Instant Dosa Mix

Fig. 17, Soghum Pongal Mix

D) INSTANT PONGAL MIX

Description of the technology

Pongal is a delicious south Indian traditional breakfast recipe, generally prepared from rice and green gram.

We have made an attempt to prepare instant pongal mix using processed sorghum, green gram dhal, spices & condiments. The mix has to be added to three cups boling water and cooked in pressure cooker for upto three whistles mixed with ghee or milk to make round balls before serving. The formulated mix was packed in a MPET packing material.

Advantages and Uniqueness of technology/Product

- Instantly Pongal can be prepared with added flavor and taste.
- It is Gluten Free and safe for Celiac Patients.
- Rich source of phenolic compounds and causes satiety resulting in slower digestibility.
- Reduces oxidative stress (Antioxidant)
- Low calorie diet (through Dietary fiber) promotes healthy digestion.
- It fights against Arthritis and Rheumatism
- Shelf life for a period of one year.

Nutritional Instant Pongal Mix (per 100 g.)

Nutrients (100 g)	Value
Energy (kcal)	348
Carbohydrates (g)	69.4
Protein (g)	13.2
Fat (g)	2.1
Fibre (g)	1.54

Sorghum Processed grain (Thick Flakes) & Green gram dal (Weighing)
↓
Add Spices & Condiments
↓
Mixing
↓
Packaging

Fig. 18, Process flow chart for production of Instant Pongal Mix

E) MILLET INSTANT LADDU MIX

Description of the technology

Ladduan Indian sweet made from a mixture of flour/semolina, powdered low calorie sugar, and shortening, which is shaped into a ball.

Millet laddu mix is developed from roasted sorghum fine rawa, finger millet flour, pearl millet flour; adding to it powdered low calorie sugar, dry fruits and cardamom are added.

The mix has to be mixed with ghee or milk to make round balls before serving. The formulated mix was packed in a MPET packing material.

Advantages and Uniqueness of technology/Product

- Instantly laddus can be prepared with added flavor and taste.
- It is Gluten Free and safe for Celiac Patients.
- Rich source of phenolic compounds and causes satiety resulting in slower digestibility.
- Reduces oxidative stress (Antioxidant)
- Contains low calorie sugar and promotes healthy digestion by presence of dietary fibre.
- It fights against Arthritis and Rheumatism
- Shelf life resulted in three months when stored at ambient temperature

Fig. 19, Millet Laddu

Instant Laddu Mix (Millets)
↓
Millet Flour (Sorghum, Finger Millet & Pearl Millet)
↓
Sieving
↓
Roasting
↓
Cooling
↓
Add Sugar Powder
↓
Add fried dry fruits and cardamom
↓
Packaging

Fig. 20, Process flow chart for production of Instant Laddu Mix

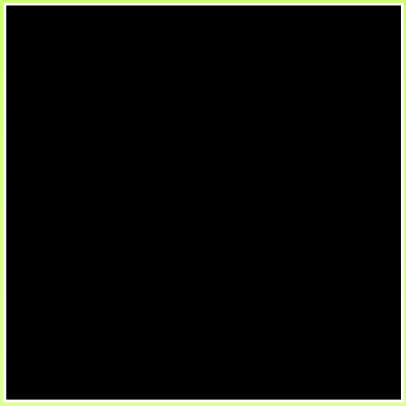

Fig. 21, Sorghum Muesli

Sorghum Flakes
↓
Add Honey
↓
Add Roasted Dry fruits
↓
Mixing
↓
Sorghum Muesli
↓
Packaging

Fig. 22, Process flow chart for production of Sorghum Muesli

7. SORGHUM MUESLI

Description of the technology

Muesli is a product made by mixing of honey and dry fruits to sorghum flakes.

We have made an attempt to prepare sorghum muesli mix where, thick flakes were dry roasted and then coated with honey. Cashew nuts, almonds, pista, raisins were roasted and added to this.

Advantages and Uniqueness of technology/Product

- Utility as snack item or along with milk.
- It is Gluten Free and safe for Celiac Patients.
- Rich source of phenolic compounds and causes satiety resulting in slower digestibility.
- Reduces oxidative stress (Antioxidant)
- Low calorie diet (through Dietary fibre) promotes healthy digestion.
- It fights against Arthritis and Rheumatism
- Shelf life for a period of one year.

Nutritional Composition of Sorghum Muesli (100 g.)

NUTRIENTS (100 g)	VALUE
Energy (kcal)	342.4
Carbohydrates (g)	75.4
Protein (g)	17.1
Fat (g)	2.1
Fibre (g)	1.7

8. MILLETS SEMOLINA (RAWA/SUJI)

Description of the technology (for all millets)

Semolina are ready to cook foods. Millet grains (Pearl Millet, Finger Millet and Foxtail Millet) are processed by dry milling.

The dry milling process starts with the cleaning of grains. The cleaned grain is milled by the hammer mills to separate the endosperm, germ and bran from each other to get semolina.

Millets Semolina: (3 variants) Millet grain is pulverised to get semolina; variants differ with particle size. According to the variant needed to process the mesh size in the mill is adjusted.

Products and by products (for all millets)

- Coarse Semolina (Kichidi rawa) yield – 68-72%; By-product yield – 32-28% (contains medium/fine semolina, flour and bran)
- Medium Semolina (Upma Rawa) yield – 71-76% ; By-product yield – 29-24% (contains coarse/fine semolina, flour and bran)
- Fine Semolina (Idli rawa) yield – 74-80%; By product yield – 26-20% (contains coarse/medium semolina, flour and bran)

Advantages and Uniqueness of technology/Product

- Utility can be used to make upma, khichidi, rawa laddu, idli, dosa, kesari etc.
- They are rich in protein, fibre, iron, and zinc.
- All three rawa can be stored for a period of 4 months for pearl millet and finger millet. The rawa for foxtail millet can be stored for 3 months and shelf life analyses are still in progress

Nutritional Composition of Millet Rawa (per 100 g.)

Nutrients (100 g)	Bajra Idli Rawa	Bajra Upma Rawa	Ragi Idli Rawa	Ragi Upma Rawa	Korra Idli Rawa	Korra Upma Rawa
Protein (g)	16.1	16.3	13.1	14.1	11.1	12.1
Fat (g)	3.2	3.1	3.4	3.6	2.5	2.7
Fibre (g)	1.6	1.7	1.2	1.4	1.6	1.7

Fig. 23, Millet Rava Kesari

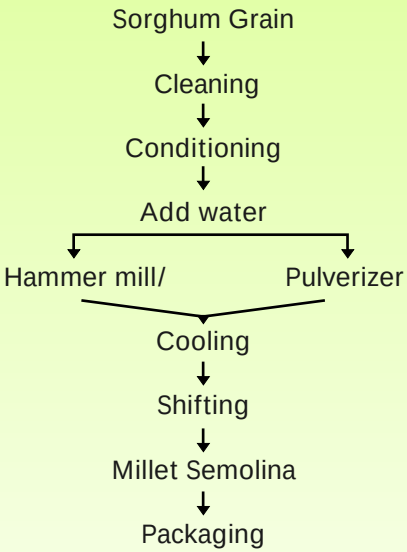

Fig.24. Process flow chart for production of Millet rawa

Fig. 25, Millet Roti

Millets (Finger, Pearl & Foxtail Millet)
↓
Cleaning
↓
Hammer mill
↓
Cooling
↓
Flour
↓
Packaging

Fig. 26. Process flow chart for production of Millet flour

9. MILLETS FLOUR

Description of the technology (for all millets)

Flour is used as a main ingredient for various recipes. Millet grains (Pearl Millet, Finger Millet and Foxtail Millet) are processed by dry milling.

The dry milling process starts with the cleaning of grains. The cleaned grain is milled by the hammer mills to separate the endosperm, germ and bran from each other to get fine flour.

Ragi flour, Bajra flour and foxtail millet flour: These four flours (atta) have been developed

Products and by products

- Flour yield – 89%; By-product yield – 11% (Bran)

Advantages and Uniqueness of technology/Product

- It is rich in magnesium, zinc, iron, dietary fiber and protein.
- Used to make rotis and bakery foods (cakes and biscuits).
- Sorghum flour, Ragi flour and Bajra can be stored for two months at ambient temperature; Foxtail millet flour studies are still in progress.

Nutritional Composition of Millet Flour (per 100 g)

Nutrients (100 g)	Bajra Flour	Ragi Flour	Korra Flour
Protein (g)	6.1	7.1	5.1
Fat (g)	2.2	2.4	2.5
Fibre (g)	1.5	1.2	1.4

10. MILLETS VERMICELLI

Description of the technology (for all millets)

Vermicelli is prepared using cold extrusion. This is very useful because of its low cost and continuous processing capability has been accepted as one of the most useful technologies during the recent years in the field of food processing.

Finger millet /Foxtail millet /Pearl millet semolina and refined wheat semolina are blended in the mixing compartment of the vermicelli-making machine and blended with water for 30 minutes and extruded using a round die.

The vermicelli is allowed to temper in room temperature for 8 hours and then dry in a cabinet drier for 6 hours.

Products and by products

- Vermicelli yield – 99%; By-product yield – 1% (negligible)

Advantages and Uniqueness of technology/Product

- Used to make semiya (sweet/spicy) and can be added to milk
- Finger millet vermicelli can be stored for six months at ambient temperature; Pearl milletvermicellishelf life studies are still in progress.

Nutrient composition for Millets Vermicelli (per 100 g)

Nutrients (100 g)	Ragi vermicelli	Bajra vermicelli	Korra vermicelli
Protein (%)	9.39	8.39	7.65
Fat (%)	1.02	1.38	1.24
Dietary fibre (g)	1.2	1.88	1.32

Fig. 27, Millet Vermicelli kheer (Payasam)

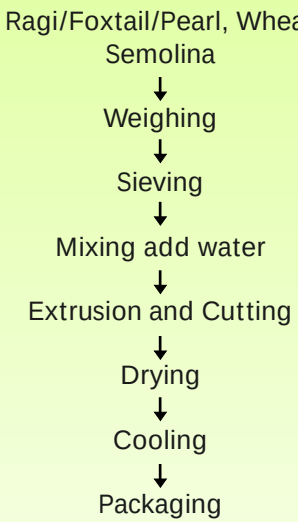

Fig. 28, Process flow chart for production of Millet vermicelli {Add Below flowchart}

Fig. 29, Millet Pasta

Ragi/Foxtail/Pearl,
Wheat Semolina
↓
Weighing
↓
Sieving
↓
Mixing
↓
Add water
↓
Extrusion and Cutting
↓
Drying
↓
Cooling
↓
Packaging

Fig. 30, Process flow chart for production of Millet pasta {Add Below flowchart}

11. MILLETS PASTA

Description of the technology (for all millets)

Pasta is prepared using cold extrusion. This is very useful because of its low cost and continuous processing capability has been accepted as one of the most useful technologies during the recent years in the field of food processing.

Sorghum/Finger millet /Foxtail millet /Pearl millet semolina and refined wheat semolina are blended in the mixing compartment of the vermicelli-making machine and blended with water for 30 minutes and extruded using a pasta die. Wheat is added as the less gluten content of millets requires minimum percentage of wheat for preparing pasta.

Products and by products

- Pasta yield – 99%; By-product yield – 1% (negligible)

Advantages and Uniqueness of technology/Product

- Utility as breakfast food
- Can be stored for three months at ambient temperature; Finger millet /Foxtail millet /Pearl millet vermicelli shelf life studies are still in progress

Nutrient composition for Millets Vermicelli (per 100 g)

Nutrients (100 g)	Ragi vermicelli	Bajra vermicelli
Protein (%)	9.39	8.39
Fat (%)	1.02	1.38
Dietary fibre (g)	1.2	1.88

12. BAKERY PRODUCTS

Description of the technology (for all millets)

Now a day's individuals have virtually no time to invest much on making breakfast it is the cookie, bread/bun, cake etc., which had occurred instead of other sorts of stuff. Consumers prefer healthy products to conventional foods, hence are these days showing preference to millet based bakery foods.

Millets were incorporated indifferent variations from 10% to 50% levels to standardize cookies (100%), bread/bun (50%) and cake (100%) by replacing refined wheat flour or using 100% millet flour at IIMR.

It is the need of the hour to develop bakery foods as convenience foods and IIMR has carried out research in developing millet based RTE bakery foods described, here under.

A) MILLETS COOKIES

Description of the technology

Cookies are popular ready-to-eat product consumed by different age groups in a family. Cookie of 100% millets is prepared using a planetary mixer, automatic cookie making machine and rotary oven.

Cookies have been prepared at IIMR using the formulation pearl millet, finger millet and foxtail millet flour of superior quality with addition of sugar, milk solids, trans free-fat, salt and nature identical flavoring substances.

Products and by products

- Cookie – 92%; By-product yield – 8% (Dough left in the machine, Broken cookies or unbaked)

Advantages and Uniqueness of technology/Product

- Pure Millet biscuits are fiber rich and beneficial for all age groups.
- Low sugar and low fat compared to the market products.
- It is rich in magnesium, zinc, iron, dietary fiber and protein.
- It has a shelf life of 6 months.

Fig. 31, Millet Cookies

Flour (Ragi/ Foxtail/Pearl: Wheat)
↓
Sugar, Milk Solids, Salt Flavouring
↓
Planetary Mixer
↓
Automatic Cookie Machine Collection of Cookies
↓
Rotary Oven
↓
Cooling
↓
Packaging

Fig.32. Process flow chart for production of Millets Cookies

Nuutrient composition for MIllets Biscuit (per 100 g.)

Nutrients (100g)	Ragi Biscuit	Bajra Biscuit
Protein (%)	7.4	7.39
Fat (%)	21.3	23.3
Dietary fiber (g)	1.9	1.4

Fig. 33, Millet Bread

Millets Bread /Bun

↓

Ragi/Foxtail/Pearl Flour, Wheat
Add Yeast

↓

Add Free Fat, Salt and Sugar

↓

Dough Kneading

↓

Panning

↓

Proofing

↓

Knock Backing

↓

Shaping

↓

Baking

↓

Depanning

↓

Cooling

↓

Slicing

↓

Packaging

Fig.34. Process flow chart for production of Millets Bread {Add below flowchart}

B) MILLETS BREAD/ BUN

Description of the technology

Bread is a RTE product which is prepared by mixing a mixture of flour, water, fat, salt and yeast until the mixture gets converted into dough, which is followed by baking the dough into a loaf.

Millet breads have been prepared at IIMR of replacing 50% wheat in bread with pearl millet, finger millet or foxtail millet flour of varied proportions and adding superior quality yeast, trans-free fat, salt and sugar.

The dough is proofed and then baked in oven to get bread. Round balls of the dough is made and baked to get bun

Advantages and Uniqueness of technology/Product

- Millet bread is fiber rich and beneficial for all age groups.
- Utility as breakfast food
- It is rich in magnesium, zinc, iron, dietary fiber and protein.
- It has a shelf life of 6 days when packed in LDPE packets.

Nutrient composition for Millets Bread (per 100 g.)

Nutrients (100 g)	Millet Bread
Protein (%)	7.4
Fat (%)	12.3
Dietary fibre (g)	0.8

C) MILLETS CAKE

Description of the technology

Cake is a RTE product which is prepared by mixing a mixture of flour, sugar, fat, eggs and flavoring ingredients until the mixture gets converted into dough, which is followed by baking the dough.

Millet cakes have been prepared at IIMR using 100% pearl millet, finger millet or foxtail millet flour and adding superior quality fat, sugar, eggs and chocolate/vanilla essence; and also adding all the millets together with varied proportions. Of all the cakes made finger millet cake was highly acceptable.

Advantages and Uniqueness of technology/Product

- Millet cake is fiber rich and beneficial for all age groups.
- Utility as snack food or breakfast food
- It is rich in magnesium, zinc, iron, dietary fiber and protein.
- It has a shelf life of 4 days when packed in MET packets.

Nutrient composition for Millets Cake (per 100 g.)

Nutrients (100 g)	Millet Cake
Protein (%)	9.4
Fat (%)	25.3
Dietary fibre (g)	1.8

Fig. 35, Millet Cake

Add fat, sugar and eggs
↓
Whisk till creamy consistency
↓
Add Sorghum/Pearl millet / Finger millet or Foxtail millet flour
↓
Add chocolate/vanilla essence
↓
Put in baking mould lined with parchment paper
↓
Bake in oven Drying at 180 Degree Centigrade for 25 min
↓
Cool and Pack

Fig. 36, Process flow chart for production of Millets Cake

Fig. 37, Millet Pizza Base

Wheat Flour
↓
Sieving
↓
Add Sugar, Fat, Yeast & Egg
↓
Add Flavour
↓
Kneading
↓
Add Water
↓
Rolling and Sheeting
↓
Baking
↓
Cooing
↓
Cutting
↓
Packaging

Fig.38, Process flow chart for production of Millets Pizza base

D) MILLETS PIZZA BASE

Description of the technology

Pizza is a RTE product which is prepared by mixing a mixture of flour, yeast, salt fat and flavoring ingredients (parsley) until the mixture gets converted into dough, which is followed by baking the dough.

Millet pizza have been prepared at IIMR using 50% sorghum, pearl millet, finger millet or foxtail millet flour, 50% fine wheat flour, adding superior quality fat,yeast, salt and sugar; and also adding all the millets together with varied proportions. Of all the pizza base made sorghum pizza base was highly acceptable.

Advantages and Uniqueness of technology/Product

- Pizza base is fiber rich and beneficial for all age groups.
- Utility as snack food or breakfast food
- It is rich in magnesium, zinc, iron, dietary fiber and protein.
- It has a shelf life of 4 days when packed in MET packets.

Nutritional profile of Millets Pizza base

Nutrients (100 g)	Millet Pizza base
Protein (%)	6.4
Fat (%)	21.3
Dietary fibre (g)	4.8

13. VALUE ADDITION FROM BY PRODUCTS

I. BY-PRODUCT FROM FLAKING OF SORGHUM

The by-product from flaking of sorghum is bran (seed-coat) powder and broken flakes. As sorghum bran and broken flakes are rich in fibre, iron and vitamin content it can be used to make various value added products. The value added products developed from the by-products are:

A) SORGHUM BRAN PEDA (SWEET)

Description of the technology

This is a sweet, a delicacy dessert prepared in India. It is thick, semi-soft pieces in which sorghum bran powder, sugar, ghee, milk powder and cardamom are the main ingredients. The sorghum bran is roasted and grinded to fine powder, powdered sugar, milk powder and cardamom powder are added to the bran powder and mixed well. Ghee is added slowly to the powder and made in to small balls. The balls are decorated with almond or cashew nuts

Advantages and Uniqueness of technology/Product

- The bran peda is similar organoleptically to rice peda.
- Utility as traditional snack food
- The peda can be stored for 7 days at room temperature in MET pouches.
- It is rich in magnesium, zinc, iron, dietary fiber and protein.

Nutrient composition for Sorghum Bran Peda (per 100 g.)

Nutrients (100 g)	Sorghum Bran Peda
Protein (%)	9.4
Fat (%)	18.1
Dietary fibre (g)	17.8

Fig. 39, Sorghum Bran Peda

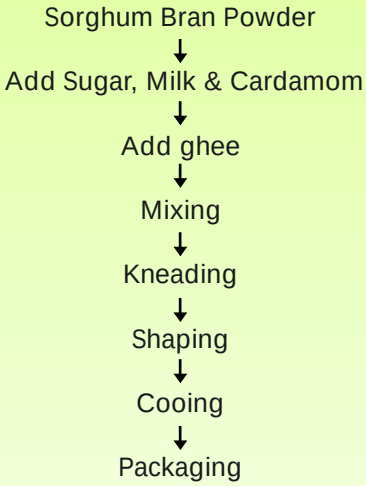

Fig. 40, Process flow chart for production of Sorghum Bran Peda

Fig. 41, Sorghum Energy Bar

B) SORGHUM BASED ENERGY BARS

Description of the technology

The energy bar is one of the value added by-product made from bran and broken flakes during flaking of sorghum. The bran is finely powdered and dried to remove the moisture present in it. Along with bran and flakes, honey syrup was added as a binder and sweetener in formulating the product.

The product is a healthy and ready source of energy and can be used as a part of normal diet or as a source of energy in emergency.

Advantages and Uniqueness of technology/Product

- Sorghum is rich in dietary fibre and minerals like iron, it is good for sports people.
- Utility as snack food
- The energy bars can be stored for two weeks at room temperature in MET pouches.
- It is rich in iron, zinc, slow digestible carbohydrates and dietary fiber.

Weiging Sorghum Bran Powder and Broken Flakes
↓
Mixing
↓
Add Binder and Sweetener (Honey Syrup)
↓
Shaping
↓
Cooing
↓
Packaging

Fig. 42, Process flow chart for production of Sorghum Energy Bar

C) SORGHUM BRAN FRYUMS

Description of the technology

The bran obtained after flaking of sorghum grain is collected and is boiled in water. Ingredients like Black gram dal flour, salt, green chilli paste, black pepper powder and baking soda are mixed in the mixture to prepare dough. Small quantity of dough is taken and filled in hand operated murukku making machine. Murukkus are made into 3-4 rounds as fryums and are dried under the sun.

Make sure that two sides of the fryum is dried. Store them in zip lock covers until further use. The dried fryums are deep fried and served alongside with sambar and rice. The bran fryums can be stored for one month at room temperature in MET pouches.

Advantages and Uniqueness of technology/Product

- Utility as an appetizer, snack food, tea-time snacks or alongside traditional south Indian meal.
- It is rich in fibre, protein, slow digestible carbohydrates and dietary fiber.
- The bran fryums can be stored for one month at room temperature in MET pouches.

Fig. 43, Sorghum Bran fryums

Sorghum Flakes byproduct (Bran)
↓
Boiling
↓
Add other Ingredient (As mentioned above)
↓
Mixing
↓
Extrusion through muruku machine (3 rounds)
↓
Sun Drying
↓
Cooling
↓
Packaging

Fig.44. Process flow chart for production of Sorghum Bran fryums

Fig. 45, Zinch rich (Gingelly seed)

Semolina (Ragi/Foxtail/Pearl: Wheat) + Gingelly Seed
↓
Bending
↓
Kneading
↓
Add water
↓
Cold Extrusion and Cutting
↓
Collection of Vermicelli
↓
Drying
↓
Packaging

Fig.46. Process flow chart for production of jowar gingelly vermicelli

14. BIO-FORTIFIED AND VALUE ADDED SORGHUM PRODUCTS

(a) Zinc rich (Gingelly seed) Jowar Vermicelli

Description of the technology

Vermicelli, popular instant snack food has been used from centuries in Indian culinary to prepare traditional sweets and savories which is prepared from wheat/ refined wheat flour.

Zinc rich Jowar vermicelli can be prepared by incorporation of processed gingelly seed powder, jowar semolina and wheat semolina through extrusion process. Processing of gingelly seed includes soaking the seed overnight and dehulling the seed and drying in tray dryer and powdering the seed.

It is used to prepare traditional sweets and savories in lieu of wheat/refined wheat flour vermicelli to obtain nutritional benefits.

Advantages and Uniqueness of technology/Product

- Gingelly seed is rich in zinc, iron, magnesium including vitamins, minerals, natural oils, and organic compounds which consist of calcium, iron, magnesium, phosphorous, manganese, copper, zinc, fiber, thiamin, vitamin B6, folate, protein, and tryptophan
- Vermicelli is one of the convenient product in terms of easy preparation and highly nutritional and digests slowly, which is why it is suitable for diabetics.
- It has a shelf life of 3 months and shelf life studies are in progress.

Nutritional composition Iron rich (Gingelly) Jowar Vermicelli (per 100 g.)

Nutrients (100 g)	Value
Protein (g)	11.4
Fat (g)	0.51
Dietary Fibre (g)	0.52
Carbohydrate (g)	75.2
Energy (Kcal)	348.4

(B) ZINC RICH (GINGELLY SEED) JOWAR PASTA

Description of the technology

Pasta is the RTC (Ready to cook) products prepared from cold extrusion of wheat semolina. The availability of advance technology made feasible to producing commercial products out of sorghum.

Iron rich Jowar pasta can be prepared by incorporation of processed gingelly seed powder, jowar semolina and wheat semolina through extrusion process. Processing of gingelly seed includes soaking the seed overnight and dehulling the seed and drying in tray dryer and powdering the seed.

It is used to prepare pasta in lieu of wheat/ refined wheat flour vermicelli to obtain nutritional benefits.

Advantages and Uniqueness of technology/Product

- It is an ideal meal for people who pay more attention to their dietary intake.
- Gingelly seed is rich in iron, magnesium including vitamins, minerals, natural oils, and organic compounds which consist of calcium, iron, magnesium, phosphorous, manganese, copper, zinc, fiber, thiamin, vitamin B6, folate, protein, and tryptophan
- Pasta is one of the convenient product in terms of easy preparation.
- Gingelly incorporate Sorghum products are highly nutritional and digest slowly, which is why it is suitable for diabetics.
- It has a shelf life of 3 months and shelf life studies are in progress.

Nutritional composition Iron rich (Gengelly) Jowar pasta (per 100 g.)

Nutrients (100 g)	Value
Protein (g)	11.4
Fat (g)	0.51
Dietary Fibre (g)	0.52
Carbohydrate (g)	76.2
Energy (Kcal)	350.4

Fig. 47, Zinc rich (gingelly seed) Jowar Pasta

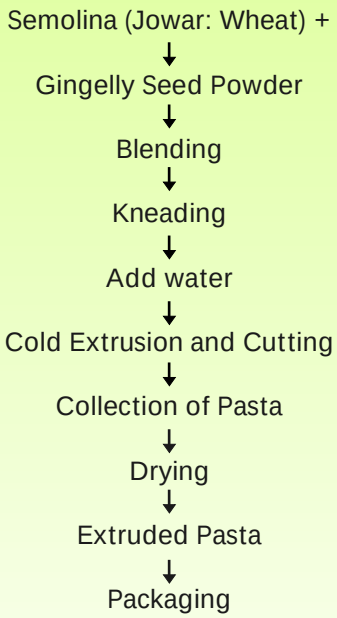

Fig.48. Process flow chart for production of jowar gingelly pasta.

Fig. 49, Zinc rich (gingelly seed) Jowar Biscuits

Wheat) + Gingelly Seed
↓
Planetary Mixer
↓
Add Sugar Powder and Fat
↓
Kneading
↓
Rolling
↓
Cutting
↓
Baking
↓
Cooling
↓
Packaging

Fig.50. Process flow chart for production of jowar gingelly biscuits

(C) ZINC RICH (GINGELLY SEED) JOWAR BISCUITS

Description of the technology

Biscuits are popular ready-to-eat product consumed by different age groups in a family.

Processing of gingelly seed includes soaking the seed overnight and dehulling the seed and drying in tray dryer and powdering the seed.

The procedure of making Iron rich Jowar biscuits includes creaming (fat and sugar powder), mixing with processed gingelly seed powder, sorghum flour in a planetary mixer; dough making, rolling, cutting into shapes in an automatic biscuit cutting machine and baking.

Advantages and Uniqueness of technology/Product

- Gingelly incorporated Pure Jowar biscuits require less fat in the procedure as gingelly seed are contain polyunsaturated fat (PUFA) and are fiber rich and beneficial for all age groups
- Low sugar and low fat and good for CVD patients compared to the market products
- Iron rich Sorghum biscuits have less sugar and less fat and rich in fiber, protein, calcium, iron and magnesium.
- It has a shelf life of 4 months and shelf life analysis is under progress.

Nutritional profile of Zinc rich (Gingelly) Jowar Biscuit (per 100g)

Nutrients (100 g)	Value
Protein (g)	12.4
Fat (g)	6.3
Dietary Fibre (g)	2.2
Carbohydrate (g)	76.3
Energy (Kcal)	485

(D) IRON RICH (GARDEN CRESS) JOWAR VERMICELLI

Description of the technology

Vermicelli, popular instant snack food has been used from centuries in Indian culinary to prepare traditional sweets and savories which is prepared from wheat/ refined wheat flour.

Iron rich Jowar vermicelli can be prepared by incorporation of processed garden cress seed powder, jowar semolina and wheat semolina through extrusion process. Processing of garden cress seed includes boiling of seed in water, removing of the slimy seed from the mixture after cooling and drying in tray dryer and powdering the seed.

It is used to prepare traditional sweets and savories in lieu of wheat/ refined wheat flour vermicelli to obtain nutritional benefits.

Advantages and Uniqueness of technology/Product

- Garden cress is rich in iron, magnesium, zinc, calcium and protein rich.
- It helps recover from atony, reduces muscle tension, increases appetite, helps asthma sufferers, alleviates breathing difficulties and purifies the lungs.
- Vermicelli is one of the convenient product in terms of easy preparation.
- Garden cress along with sorghum impedes enzymatic hydrolysis which is why it is suitable for diabetics.
- It has a shelf life of 4 months and shelf life studies are in progress.

Nutritional profile Iron rich (Garden cress) Jowar Vermicelli (per 100 g.)

Nutrients (100 g)	Value
Protein (g)	11.4
Fat (g)	0.51
Dietary Fibre (g)	0.52
Carbohydrate (g)	85.2
Energy (Kcal)	328.4

Fig. 51, Iron rich (gardencress) Jowar Vermicelli

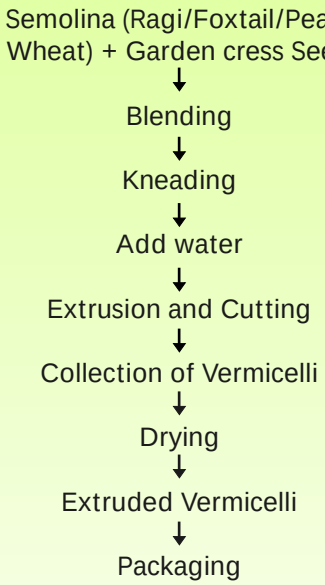

Fig. 52, Process flow chart for production of jowar gardencress vermicelli.

Fig. 53, Iron rich (gardencress) Jowar Vermicelli

Semolina (Jowar: Wheat) + Garden cress Seed Powder
↓
Blending
↓
Kneading
↓
Add Water
↓
Extrusion and Cutting
↓
Collection of Pasta
↓
Drying
↓
Extruded Pasta
↓
Packaging

Fig. 54, Process flow chart for production of jowar gardencress pasta

(E) IRON RICH (GARDEN CRESS SEED) JOWAR PASTA

Description of the technology

Pasta is the RTC (Ready to cook) products prepared from cold extrusion of wheat semolina. The availability of advance technology made feasible to producing commercial products out of sorghum.

Iron rich Jowar pasta can be prepared by incorporation of processed garden cress seed powder, jowar semolina and wheat semolina through extrusion process. Processing of garden cress seed includes boiling of seed in three times water at exactly 90°C, removing of the slimy seed from the mixture after cooling and drying in tray dryer and powdering the seed.

It is used to prepare pasta in lieu of wheat/ refined wheat flour vermicelli to obtain nutritional benefits.

Advantages and Uniqueness of technology/Product

- Garden cress is rich in iron, magnesium, zinc, calcium and protein rich.
- It helps recover from atony, reduces muscle tension, increases appetite, helps asthma sufferers, alleviates breathing difficulties and purifies the lungs.
- Pasta is one of the convenient product in terms of easy preparation.
- Garden cress along with sorghum impedes enzymatic hydrolysis which is why it is suitable for diabetics.
- It has a shelf life of 4 months and shelf life studies are in progress.

Nutritional profile of Iron rich (Garden cress) Jowar Pasta

Nutrients (100 g)	Value
Protein (g)	11.4
Fat (g)	0.51
Dietary Fibre (g)	0.52
Carbohydrate (g)	86.5
Energy (Kcal)	332.4

15. MILLET ROTI-MAKING MACHINES

Description of the machine

Jointly developed by IIMR in association with private entrepreneur

Version 1	Version 2	Version 3
Foot operated	Hand operated	Hand operated
More space required	Less space required	Less space required
Capacity 40 rotis/hr	Capacity 50-60 rotis/hr	Capacity 80-100 rotis/hr
Low speed (150 rpm)	medium speed (200 rpm)	High speed (250 rpm)
Cost : Rs 25 K	Cost : Rs 10 K	Cost : Rs 8 K

Version - 1

Version - 4

Version - 3

Version - 2

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.

Fig. 55, Millet roti-making machines

Fig. 56, Jowar Atta & roti

Nutritional Composition of Sorghum Atta (per 100g)

Nutrients (100g)	Value
Protein (g)	5.1
Fat (g)	2.4
Carbohydrates (g)	75.0
Thiamin (mg)	2.3
Riboflavin (mg)	0.4
Folic acid (mg)	2.3
Calcium (mg)	10.0
Iron (mg)	8.4
Zinc (mg)	1.3
Magnesium (mg)	63.4
Energy (Kcal)	342.0

II. EATRITE PRODUCTS ALREADY COMMERCIALIZED

1. JOWAR ATTA

Description of the technology

Sorghum flour (atta) 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 in to flour in hammer mill.

The "Eatrite" brand Jowar atta is prepared from 100% natural whole grains Jowar of superior quality. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 1 kg packet.

Advantages and Uniqueness of technology/Product

- Excellent source of complex carbohydrates, fibre, B complex vitamins, calcium, iron, zinc and magnesium.
- Rich source of phyto chemicals including tannins, phenolic acids, anthocyanins, phytosterols and policosanols.
- Free from "gluten", Suitable for celiac patients.
- Low glycemic index food, suits better for diabetes, obese, hypertensive and CVD patients.
- It has a shelf life of 2 months.

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies .

RECIPE FROM JOWAR ATTA

ROTI

- Add appropriate quantity of hot water to flour and knead it to make dough.
- Cut the dough into small balls and roll it into round shape by hand patting
- Bake the roti properly on both sides on a preheated tawa.

2. JOWAR RICH MULTIGRAIN ATTA

Description of the technology

Jowar rich multigrain atta of "Eatrite" brand is prepared from careful blend of 100% natural whole grains Jowar, wheat, ragi, black gram dhal and fenugreek in the right proportion. Addition of wheat to the dough makes it pliable and allows better shaping, retaining the original roti taste.

Different grains have varied advantages, sorghum and other millets provide additional minerals, dietary fiber and micronutrients from multigrain roti's than the normal roti made from wheat.

The multigrain atta produced by "Eatrite" brand has more Jowar flour (>50%) than the other brands which are available in the market.

It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 1 kg packet.

Advantages and Uniqueness of technology/Product

- Overcomes the amino acid balance and inconvenience in roti making.
- Nutritious recipe compared to other existing market products.
- Excellent source of complex carbohydrates, dietary fibre, protein, folic acid, calcium, iron, zinc and magnesium.
- Low glycemic index food, suits better for diabetes, obese, hypertensive and CVD patients.
- It has a shelf life of 3 months.

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies

Fig. 57, Multigrain Atta

Nutritional Composition of Jowar rich multigrain atta (per 100g)

Nutrients (100g)	Value
Protein (g)	8.8
Fat (g)	3.2
Carbohydrates (g)	68.7
Thiamin (mg)	0.3
Riboflavin (mg)	0.1
Folic acid (mg)	0.9
Calcium (mg)	15.4
Iron (mg)	3.5
Zinc (mg)	1.7
Magnesium (mg)	140.2
Energy (Kcal)	339.0

Fig. 58, Jowar Rawa


Fig. 59, Jowar Kesari

Nutritional Composition of Jowar rawa (per 100g)

Nutrients (100g)	Value
Protein (g)	7.1
Fat (g)	1.2
Carbohydrates (g)	77.7
Riboflavin (mg)	1.1
Folic acid (mg)	1.2
Calcium (mg)	5.7
Iron (mg)	5.1
Zinc (mg)	1.3
Magnesium (mg)	86.0
Energy (Kcal)	350.0

3. JOWAR RAWA (SORGHUM MEDIUM SEMOLINA)

Description of the technology

Sorghum semolina (three variants) 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 in to medium size rawa in a hammer mill.

The "Eatrite" brand Jowar rawa is prepared from 100% natural whole grains of superior quality. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 500g packet.

Advantages and Uniqueness of technology/Product

- Excellent source of complex carbohydrates, protein, fibre, calcium, iron, zinc and magnesium.
- Free from "gluten", Suitable for celiac patients.
- Low glycemic index food, suits better for diabetes, obese, hypertensive and CVD patients.
- No added preservatives
- It has a shelf life of 3 months.

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies

RECIPES FROM JOWAR RAWA

KESARI

- Roast Jowar rawa until light brown with little oil.
- Sauté dry fruits on low flame.
- Boil milk and add pinch of kesar to it.
- Add roasted rawa and sugar to boiled milk and allow it to cook for 15 minutes.
- Garnish with dry fruits and add little ghee before serving hot.

4. JOWAR KHICHIDI RAWA(SORGHUM COARSE SEMOLINA

Description of the technology

Sorghum khichidi rawa is made through milling technology.

The "Eatrite" brand Jowar Kichidi Rawa is prepared from 100% natural whole grains of superior quality. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 500g packet.

Advantages and Uniqueness of technology/Product

- Excellent source of complex carbohydrates, protein, fibre, calcium, iron, zinc and magnesium.
- Free from "gluten", Suitable for celiac patients.
- Low glycemic index food, suits better for diabetes, obese, hypertensive and CVD patients.
- No added preservatives
- It has a shelf life of 3 months.

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencie

Fig. 60, Jowar Khichidi Rawa

RECIPE FROM JOWAR KHICHIDI RAWA

KHICHIDI

- Soak green moong and Jowar rawa (1:2 ratio) separately.
- Make seasoning with mustard seeds, ginger garlic paste, tomatoes, curry leaves and turmeric powder and chopped onion, green chillies.
- Add sufficient water and salt to seasoning and allow it to boil.
- Add Jowar rawa and moong dal to boiled water and cook on a low flame till it is cooked and serve hot with accomplishment.

Nutritional Composition of Jowar rawa (per 100g)

Nutrients (100g)	Value
Protein (g)	7.5
Fat (g)	2.6
Carbohydrates (g)	75.2
Riboflavin (mg)	0.5
Folic acid (mg)	2.1
Calcium (mg)	15.6
Iron (mg)	9.5
Zinc (mg)	1.4
Magnesium (mg)	79.1
Energy (Kcal)	354.0

Fig. 61, Jowar Idli Rawa

Nutritional profile of Jowar Fine Semolina/Rawa (per 100 g)

Nutrients (100g)	Value
Protein (g)	6.5
Fat (g)	1.7
Carbohydrates (g)	77.7
Thiamine (mg)	1.1
Riboflavin (mg)	2.1
Folic acid (mg)	2.5
Calcium (mg)	7.5
Iron (mg)	10.5
Zinc (mg)	1.2
Magnesium (mg)	76.5
Energy (Kcal)	353.0

5. JOWAR IDLI RAWA (SORGHUM FINE SEMOLINA)

Description of the technology

Sorghum fine semolina is extracted using machinery called "Brabender junior". The "Eatrite" brand Jowar idli rawa is exclusively prepared from 100% natural whole grains of superior quality to provide nutrients from daily Idli's.

It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e, 500 g packet.

Advantages and Uniqueness of technology/Product

- Health beneficial product when compared to existing market product.
- Rich in Dietary fiber.
- Low glycemic index food, suits better for diabetes, obese, hypertensive and CVD patients.
- Excellent source of complex carbohydrates, protein, fibre, calcium, iron, zinc and magnesium.
- It has a shelf life of 3 months.

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies

RECIPE FROM JOWAR IDLI RAWA

JOWAR IDLI

- Soak Jowar Idli Rawa and black gram separately in 2:1 ratio for 5-6 hrs
- Make batter with soaked black gram dal
- Mix washed Jowar fine semolina to the batter, add salt to taste and allow for fermentation.
- After fermentation, mix batter properly and pour the batter in to greased stainless steel idly moulds and steam for 15-20 min.

6. JOWAR FLAKES

Description of the technology

Sorghum Flakes Beaten is produced by the traditional cottage scale batch process called the edge runner process. Sorghum grains are cleaned and soaked in water overnight at room temperature, roasted in grain roaster and flattened to flakes in edge-runner machine.

Jowar flakes are Ready-to-Eat products, minimizes the recipe preparation time besides promoting health.

The "Eatrite" brand Jowar flakes are exclusively prepared from 100% natural whole grains of superior quality. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 500 g packet.

Fig. 62, Jowar Flakes

Advantages and Uniqueness of technology/Product

- Jowar Flakes can be consumed as breakfast cereal to both traditional and non-traditional consumers across the country.
- Excellent nutritional composition including folic acid, calcium, iron, zinc and magnesium.
- Jowar flakes has low glycemic index and desirable product for diabetes and other life style diseases.
- Gluten Free product suitable for celiac patients
- Excellent source of folic acid, calcium, iron, zinc and magnesium.
- It has a shelf life of 3 months.

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies.

Nutritional profile ofJowar Flakes (per 100 g.)

Nutrients (100 g)	Value
Protein (g)	7.2
Fat (g)	1.8
Carbohydrates (g)	73.8
Thiamine (mg)	0.5
Riboflavin (mg)	1.2
Niacin (mg)	1.9
Folic acid (mg)	1.5
Calcium (mg)	10.9
Iron (mg)	3.4
Zinc (mg)	0.9
Magnesium (mg)	68.9
Energy (Kcal)	340.0

RECIPES FROM JOWAR FLAKES

CHUDUWA

- Roast flakes on a pan till it get crisp and keep separately.
- Fry black gram dal, channa dal, jeera, groundnuts, dried red chillies in oil & add chopped onions, pinch of turmeric powder.
- Add salt to taste then fry all these ingredients together.
- Add roasted flakes to the above ingredients mixture and mix thoroughly.

Fig. 63, Jowar Chudwa

7. JOWAR VERMICELLI

Description of the technology

Vermicelli, popular instant snack food has been used from centuries in Indian culinary to prepare traditional sweets and savories which is prepared from wheat/ refined wheat flour.

Jowar vermicelli can be prepared through extrusion process to prepare traditional sweets and savories in lieu of wheat/ refined wheat flour vermicelli to obtain nutritional benefits.

The "Eatrite" brand Jowar vermicelli is exclusively prepared from Jowar and wheat semolina of superior quality. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 180 g packet.

Fig. 64, Jowar Vermicelli

Advantages and Uniqueness of technology/Product

- It is an ideal meal for people who pay more attention to their dietary intake.
- Sorghum vermicelli is one of the convenient product in terms of easy preparation.
- It is rich in protein, calcium, iron and magnesium compared to wheat pasta
- Sorghum products are digested slowly, as, its dense structure impedes enzymatic hydrolysis which is why it is suitable for diabetics.
- It has a shelf life of 6 months.

Fig. 65, Jowar Vermicelli Kheer

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies.

Nutritional profile ofJowarVermicelli

Nutrients (100 g)	Value
Protein (g)	8.4
Fat (g)	1.4
Carbohydrates (g)	76.2
Thiamine (mg)	0.7
Riboflavin (mg)	1.3
Calcium (mg)	6.4
Iron (mg)	6.4
Zinc (mg)	0.7
Magnesium (mg)	67.5
Energy (Kcal)	355.0

RECIPES FROM JOWAR VERMICELLI

KHEER

- Sauté Jowar vermicelli and dry fruits in a pan separately.
- Boil milk and then add sautéed Jowar vermicelli.
- Add sugar and stir slowly for 10-15 minutes until it is cooked.
- Add elachi powder before turning off flame and garnish with sautéed dry fruits.

8. JOWAR PASTA

Description of the technology

Pasta is the RTC (Ready to cook)products prepared from cold extrusion of wheat semolina. The availability of advance technology made feasible to producing commercial products out of sorghum.

Sorghum pasta is prepared with sorghum semolina and wheat semolina. Lack of gluten content in sorghum requires minimum percentage of maida for texture maintaining in pasta technology.

The “Eatrite” brand Jowar pasta is exclusively prepared from Jowar and wheat semolina of superior quality. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 80 g packet.

Fig. 66, Jowar Pasta

Advantages and Uniqueness of technology/Product

- It is an ideal meal for people who pay more attention to their dietary intake.
- Sorghum pasta is easily to prepare.
- It is rich in protein, calcium, iron and magnesium compared to wheat pasta.
- Pasta products are digested slowly, as, its dense structure impedes enzymatic hydrolysis which is why it is suitable for diabetics.
- It has a shelf life of 6 months.

Fig. 67, Jowar Pasta

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies.

Nutritional profile of Jowar Pasta

Nutrients (100 g)	Value
Protein (g)	9.5
Fat (g)	1.2
Carbohydrates (g)	74.4
Thiamine (mg)	0.2
Riboflavin (mg)	0.1
Calcium (mg)	17.0
Iron (mg)	2.9
Zinc (mg)	1.0
Magnesium (mg)	54.3
Energy (Kcal)	347.0

RECIPE FROM JOWAR PASTA

PASTA

- Sauté Jowar pasta in a pan and cook gently in salted boiled water and drain water.
- Sauté chopped onions, vegetables with taste maker.
- Add cooked pasta to sautéed vegetables and cook for 5 minutes at low flame.
- Garnish with coriander leaves and cheese if required.

9. JOWAR BISCUITS

Description of the technology

Biscuits are popular ready-to-eat product consumed by different age groups in a family.

The "Eatrite" brand nutrient rich Jowar biscuits are exclusively prepared from Jowar flour of superior quality with addition of sugar, milk solids, edible vegetable oil, salt and nature identical flavoring substances.

The procedure of making biscuits includes creaming (fat and sugar powder), mixing with sorghum flour in a planetary mixer; dough making, rolling, cutting into shapes in an automatic biscuit cutting machine and baking. It is manufactured at Indian Institute of Millets Research (IIMR), Hyderabad. It is available in single SKU i.e 100 g packet

Fig. 68. Jowar Biscuits

Advantages and Uniqueness of technology/Product

- Pure Jowar biscuits are fiber rich and beneficial for all age groups
- Low sugar and low fat compared to the market products
- Sorghum biscuits have less sugar and less fat and rich in fiber, protein, calcium, iron and magnesium.
- It has a shelf life of 6 months.

Fig. 69, Jowar Biscuits

Services Offered As Part of Technology Transfer

- Training Programmes on Sorghum Processing to the farmers, rural entrepreneurs, NGOs, Women groups, Self Help Groups etc.
- Liaison with the private food players and Govt. agencies.

Nutritional profile of Jowar Biscuits (per 100 g.)

Nutrients (100 g)	Value
Protein (g)	7.7
Fat (g)	23.7
Carbohydrates (g)	60.0
Thiamine (mg)	0.2
Riboflavin (mg)	0.2
Folic acid (mg)	0.5
Calcium (mg)	68.8
Iron (mg)	2.0
Zinc (mg)	1.7
Magnesium (mg)	92.2
Energy (Kcal)	481.0

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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.

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- Provides specialized services to existing SMEs in the region.
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For more details, kindly contact
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