



PM Formalisation of Micro Food Processing Enterprises Scheme

Processing of Finger Millet Malt Food



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Introduction

Milletts belong to a group of highly variable small-seeded grasses widely grown around the world as cereal crops or grains for human food and fodder. Millets are important crops in the semi arid tropics of Asia and Africa especially in India, Mali, Nigeria, and Niger. About 99% of millet production happens in developing countries. The crop is favored due to its productivity and short growing season under dry, high temperature conditions. There is a variety of millets available in India such as foxtail millet, sorghum millet, little millet, kodo millet and pearl millet. Some of the unique features possessed by small millets are:

1) They can grow well even in areas where soil, climate and other conditions are less favourable for crop growth.

2) Their grains are small and yields are stable. The grains store well for long periods ensuring food supply in years of crop failure and in lean seasons.

3) In view of small grain size they often require less cooking time

4) Many method of using millets have been established as materials of traditional staple foods. There are also ways of processing millet into novel preparations as well. This can be a factor in increasing market demand for them. This application is closely related to the farm practices, dietary culture and agricultural rituals of rural communities.

5) Small millet grains in general have excellent nutritious properties with high levels of essential minerals such as iron, calcium, zinc, dietary fibre, quality protein, nutraceuticals etc.

6) These crops often have dual use and grown for grain and quality fodder / straw and both are equally important in mixed farming.

Finger millet is commonly known as **Ragi** in southern part of India. It is cultivated broadly in major parts of India and Africa. It is world's fourth important millet after pearl millet, sorghum and foxtail millet. Finger millet is a subtropical and tropical grain which can withstand drought and high temperature environment which inferences its sustainability to be grown-up in those areas where maize, rice, wheat and other cereals are difficult to grow. Finger millet is used as poor man's crop due to its elongated sustainable strength as it could be kept securely for a number of years devoid of any insect and pests infestation. In Africa and India, two groups are familiar: Afro-Asiatic forms with full-grown grains visible outside the florets and African highland types with grains enclosed inside the florets. Finger millet is native to the Ethiopian highlands and

commonly cultivated in more than 25 countries - Uganda, Nepal, India, Sri Lanka, Bangladesh, East China, Tanzania and Kenya etc. It is understood that Uganda or nearby areas are the primary centre of foundation of *E. coracana*, and it was brought into India probably over 3,000 years before. While concerning the production area in India, finger millet secures sixth rank after wheat, maize, sorghum, rice and bajra, but only limited sections of population are aware about its nutritional and health importance.

Grains of finger millet are tiny deep red with seed smaller than that of pearl millet and the mean value of 1000 finger millet seed grain weight is approximate to 2.6 g. It has naked caryopsis with seed coat of brick red-colour and is mostly consumed in whole meal form during making of traditional products viz., roti (unleavened breads or pancake), ambali (thin porridge) and mudde (dumpling).

Moreover, gluten free millet grains are also suitable for the patients suffering from gluten intolerance. It is an essential cereal crop because of its incredible nutritive value, which is superior to rice and identical to the wheat. Along with any other food this is one of the most nutritious food and one which is easy to digest. It is rich in calcium and protein and also has good amount of iron and other minerals. It has least amount of fat and rich in carbohydrates of around 80%. Finger millet is especially known for its excellent malting qualities which should make it an important ingredient for the preparation of several noval, high value foods.

Production status of finger millet in India

Finger millet constituted about 81% of the minor millets produced in India. The total annual production of all millets worldwide is approximately 4.5-5 million tons, with India alone producing about 2.5 million tons and some countries in Africa accounting for about 2 million tons of the grains. India is thus reported to be the largest producer of finger millet, contributing a total of 60% of the global production. In terms of production in the semi-arid regions, Finger millet ranks fourth after sorghum, pearl millet and foxtail millet respectively. Karnataka leads the scenario of finger millet production in India accounting for 58% of the total production.

Table:1 State-wise area, production and productivity of Finger millet in India: 2015-16

States/UTs	Area (In ' 000 Hectare)	Production (In' 000 Tonne)	Productivity (In Kg./Hectare)
Andhra Pradesh	32.0	34.0	1063
Bihar	6.9	9.9	1429
Chhattisgarh	6.9	1.3	188
Dadra and Nagar Haveli	0.9	1.6	1900
Goa	-	-	-
Gujarat	19.0	15.0	789
Himachal Pradesh	1.9	1.9	1027
Jammu and Kashmir	-	-	-
Jharkhand	14.3	9.2	644
Karnataka	705.0	1188.0	1685
Kerala	0.1	0.1	1180
Madhya Pradesh	1.0	1.0	1000
Maharashtra	92.0	93.0	1011
Nagaland	0.3	0.3	970
Odisha	45.7	28.3	620
Puducherry	-	-	-
Sikkim	2.9	3.0	1042
Tamil Nadu	90.0	271.2	3013
Telangana	1.0	1.0	1000
Uttar Pradesh	-	-	-
Uttarakhand	107.4	150.6	1402
West Bengal	11.0	12.5	1136
India	1138.2	1821.9	1601

Nutritional information

Finger millet is one of the most nutritious cereals. It contains about 5–8% protein, 1–2% ether extractives, 65–75% carbohydrates, 15–20% dietary fiber and 2.5 -3.5% minerals. Of all the cereals and millets, finger millet has the highest amount of calcium (344 mg) and potassium (408mg). The cereal has low fat content (1.3%) and contains mainly unsaturated fat. 100 grams of Finger millet has roughly on an average of 336 KCal of energy in it.

Table 2 Vitamins mg/100g

Vitamin	Content
Vit A (Retinol)	6.0
Vit B ₁ (Thiamine)	0.2-0.48
Vit B ₂ (Riboflavin)	0.12
Niacin	1.0-1.30
Vit C (Ascorbic acid)	0.0-1.0

Table:3 Fatty acids g/100 g of total lipids

Fatty acid	content
Palmitic	21.1-24.7
Dleic acid	49.8
Linoleic acid	24.2
Linolenic acid	1.3-4.40

Table 4:Amino acid content mg/100 g

Amino acid	content
Phenylalanine	4.1-5.2
Histidine	2.2
Isoleucine	4.3
Leucine	6.6-9.5
Lysine	2.2
Methionine	2.5-3.1
Threonine	3.4-4.2
Tryptophan	1.1-1.5
Valine	4.9-6.6

Phenylalanine	4.1-5.2
Aspartic acid	6.5-7.9
Glutamic acid	20.3-27.1
Alanine	6.1-6.2
Arginine	2.77-4.5
Cystine	1.7-2.6
Glycine	2.14-4.0
Proline	7.0-9.9
Serine	3.6-5.1
Tyrosine	2.79-3.6

Table 5: Functions of key amino acids present in finger millet.

Valines	Essential for repair of tissues, muscle coordination and metabolism and also help maintain balance of nitrogen in the body. It also helps promote mental calmness and enhance maintain mental vigor.
Isoleucine	Essential for ensuring blood formation, keeping a check on blood sugar levels. It also helps heal and repair muscle tissues, bones and skin.
Threonine	Helps maintain protein levels in the body. It also helps formation of tooth enamel, also prevents formation of fat in the liver.
Tryptophan	Act as natural relaxant and help fight anxiety, depression and insomnia. They also help in treating migraine headaches. They reduce excess appetite and help control weight gain; they also release of growth hormones.
Methionine	Sulfur based amino acid which is essential for various activities in human body. It is said to help promote growth of healthy skin and called lecithin which helps reduce cholesterol, reduce fat inside the livers and help protect kidneys. This methionine is generally lacking in staple diet of some of the vegetarians and hence regular Ragi intake will help get enough of these amino acids.

Health Benefits of finger millet

Control Diabetes

The grain's seed coat is abundant in polyphenols and dietary fibres as compared to rice, maize or wheat. The low glycemic index lessens food cravings and maintains the digestive pace, consequently, keeping blood sugar within the safe range. It is best to add it to your morning meal or have it for lunch in order to keep our system on track the whole day.

Rich source of Calcium

Finger millet is one of the best sources of calcium when compared to any other grains. According to the National Institute of Nutrition in India, 100 grams of Ragi contains 344 mg calcium. It is critical for healthy bones and teeth and prevention of osteoporosis. It is extremely beneficial for growing kids.

Prevent Ageing

Finger millet works wonders for maintaining young and youthful skin. Vital amino acids like Methionine and Lysine present in it make the skin tissues less prone to wrinkles and sagging. Ragi is also one of the very few natural sources of Vitamin D which is mostly derived from sunlight. Vitamin D is a carrier molecule for calcium, which accounts for vitality.

Prevent Anemia

Finger millet is an excellent source of natural iron and thus a boon for anemia. Once ragi is allowed to sprout, the Vitamin C levels tend to increase and lead to easy absorption of iron into the bloodstream.

Relaxes the Body

Regular consumption of Finger millet is highly beneficial in dealing with conditions of anxiety, depression and insomnia. The presence of antioxidants, mainly Tryptophan and amino acids, helps as they work as natural relaxants.

Weight Reduction

The high amount of dietary fiber combine keeps the stomach full for a longer and prevents unwanted cravings. This in turn leads to a minimized appetite and weight loss. Finger millet lowers the blood sugar levels in the body by activating insulin.

Table.6: Potential health benefits of finger millet

Health compounds	Functions
Ferulic acid	Prevents tissue damage and stimulates wound healing process.
Phytic acid	Plays an important role in lowering body cholesterol.
Phytates, phenols and Tannins	Important in healing, aging and metabolis syndrome. Prevents deterioration of human health, cancer and cardiovascular diseases. Lowering of blood pressure and diabetes. Decreases tumour.
Dietary fibre	Essential for hypoglycemic and hypolipidemic effect as well as lowering of serum cholesterol. Prevents atherosclerosis, antitoxic effect and anticancerous effect
Nutraceutical foods	Promotes better health by reducing the risk of chronic diseases such as obesity. Lowers blood pressure, cancer and diabetes.
Magnesium	Reduces the risk of heart attack.
Phosphorus	Essential for the development of body tissue and energy metabolism

Harvesting and Handling

In general the crop is harvested by hand. Individual heads are cut off with a knife, leaving a few centimeters of stalk attached. These are piled in heaps for a few days, which fosters fermentation whose heat and hydrolysis makes the seeds easier to thresh. Finger millet seeds are so small that weevils cannot squeeze inside. In fact, its unthreshed heads resist storage pests so well they can be stored for 10 years or more without insect damage.

Technological processes of finger millet food products.

Cooking

It is a processing method that involves boiling finger millet grains in water until the grain becomes soft, mashed and again mixed with water to give a final product soup. Grueling helps to reduce the microbial load and improves the desirable sensory quality of the cooked grain. Cooking of finger millet grains can also be prepared by mixing boiled water and flour to produce porridge

Milling

The most common traditional processing method that converts dried and moistened cereal grains into flour by using wooden or stone mortar and pestle. Milling or grinding is normally practiced in developing countries by mostly women. The milling process of grains consists of sorting, cleaning, hulling, branning and kilning for further processing. Finger millet grain requires dehulling and debranning before consumption because finger millet grain contains large portions of husk and bran. During milling process, about 10% of water is added to the grain in order to facilitate the removal of fibrous husk. Milling is mostly done to remove the fibrous coarse bran or the seed coat of the grains. Furthermore, removal of some phytochemicals such as phytates and tannin during milling improves the bioavailability of iron

Fermentation

Fermentation is a processing method widely used on finger millet grains whereby the raw material becomes the medium of growth for the microorganism. The fermentation process as a means of food processing has been employed traditionally and continues to be applied in the production of fermented foods and beverages in homes, villages and in small-scale industries. Finger millet may be fermented at room temperature for 24 to 72 h depending on the product or beverages intended to be produced.

Presently, fermentation process has been upgraded and is now used in commercial industries to provide value-added products that meet the needs of the urban populace. It is also an economic process used for preserving food products. During the fermentation process, growing microorganisms produce their own byproducts such as acids or antibiotics as they break down starch. This process in turn inhibits spoilage and pathogenic microorganisms, improves amino acid balance as well as the sensory quality and nutritional value of the grains. Fermentation also provides health benefits by reducing antinutritional compounds such as tryptin, amylase inhibitor, phytic acid and tannins in cereal grains.

Puffing or popping

Puffing or popping is a traditional method used for producing ready-to-eat and stable shelf-life products which are crunchy and porous. Puffing also involves soaking whole un-husked grains in water and mixing with sand heated at 250 °C for 15-60 s. Puffed snack foods are desirable in terms of colour, texture, flavour and shape thereby enhancing consumer acceptability.

Presently, modern air puffing machines have been developed for the mass production of puffed millet grains. Puffed finger millet can be milled to flour and further enriched with

additional ingredients. Finger millet popped products have been reported to improve the pleasant aroma, acceptable taste and quality of grains by inactivating destructive bacteria. Puffing on its part, increases the digestibility and solubility of starch due to gelatinization. Puffing also increases the dietary fibre of the final products and decreases antinutritional factors.

Roasting

It is a simple traditional technology commonly practiced in households and rural areas. Roasting is similar to puffing process but differs in the volume expansion which is higher in puffing. During roasting, the antinutritional or toxic effect such as saponins, alkaloids, glycosides, gioterogenic agents, tryptin inhibitor and hemagglutinin are removed. Roasting improves the nutritional quality and increases the shelf-life of the roasted grains. Processed foods obtained as a result of roasting of finger millet grains include weaning foods which increases the bioavailability of iron

Germination

It is a traditional process where the whole unhusked grains are soaked for 2-24 h and then spread on a damp cloth for up to 24-48 h or incubated at 30°C for 48 h. Germination process has been operated at low cost without the use of expensive equipment and it is an easily adaptable technology. Germination has been used for centuries to soften the kernel structure and improve the nutritional composition and concentration of carbohydrates, minerals, vitamins and essential amino acids, thus increasing the functional properties of the grains.

Malting

It is a combined process of steeping, germination, drying, toasting, grinding and sieving in order to achieve high nutritional quality, better starch digestibility, sensory properties and reduced antinutritional activities. Malting improves the fibre, crude fat, vitamin B, C and mineral content in the grains, while antinutritional activities of tannins and phytic acid in finger millet are decreased significantly. Malting is a common technology used, as malted finger millet grains are considered of best quality when compared to malted sorghum and maize. Malted finger millet millet is produced in small scale among rural dwellers to brew local beverages. The brewed grains are then used for refreshment during community ceremonies and for consumption by farmers engaged in farming activities

Extrusion

It is a modern food processing method used in solving problems associated with the processing of small cereal based products in terms of physical state, quality, functionality

and shelf-life extension. Extrusion process has many advantages in terms of preparation of ready-to-eat foods desired in different shapes, size, texture and sensory characteristics. Extrusion has also found application in solving the problem of malnutrition in developing countries due to its beneficial process. The cooking process employed is high temperature for a short time which is used in processing starchy materials. Common advantages of extrusion cooking include low cost, high productivity, speed and high product quality. Extrusion also assists in product development without waste, increases *in-vitro* protein digestibility, versatility, unique product shapes and energy savings. During the extrusion process, protein solubility and structure are decreased and disrupted when applied under high pressure and temperature. Extrusion is a process of gelatinizing and cooking the product completely until it is fully cooked, thereby leading to the production of different forms of food.

The extrusion process is extensively applied in food industries to make breakfast cereals and snacks. Flour from various plant sources can be prepared in different forms to produce common extruded products such as snacks, noodles, macaroni, spaghetti, baby foods and pasta which are preferred by children and teenagers. Furthermore, this technology can be applied in the preparation of pet foods which are very convenient and requires short time to prepare. Snacks are ready-to-eat products which are very popular and whose demand is increasing among all age groups. Fortification of extruded products with minerals and vitamins is also employed to balance the nutritional composition that is lost during processing and to prevent micronutrient deficiencies. The extruded products can be coated with sweet or savory flavors to appeal to children

Malting of finger millet

Malting is a beneficial approach to improve the nutritional value of cereals used in infant preparations. Malted finger millet might be considered as potentially appropriate gluten-free alternative. Malting is a controlled germination and drying process that changes the microstructure of cell walls, proteins, and starch granules. The traditional process consists of steeping to increase the moisture content to a level required to initiate germination, germination to modify the kernel, and kilning to dry it.

Finger millet could be the key to providing cheap and nutritious foods for solving the malnutrition that affects millions of babies throughout the world each year.

The process of germinating finger millet activates enzymes that break down the complex structures of starches into sugars and other simple carbohydrates that are easy to digest. The enzymes are there to benefit the seeds in which they occur - to mobilize food for

the growing seedling; but long ago people found that they could use them also to break up starches from other sources. Indeed, malting is the key to making cheap, digestible, liquid foods with little effort and no extra cooking fuel. These foods are particularly promising for children facing the life-threatening dietary switch from mother's milk to solid foods.

Adding a tiny amount of malted grain turns a bowl of hot starchy porridge into a watery liquid. The resulting food matches the viscosity of a bottled baby food, such as those sold in supermarkets. A child who is too small or too weak to get solids can then get a full meal and get it out of the food its mother is preparing for the rest of the family.

The germinated grain acts as a catalyst to liquefy any of the world's major starchy foods: wheat, rice, maize, sorghum, millet, potatoes, cassava, yams, etc. Moreover, it does more than turn those staples into liquid form: it predigests the starches, making the food easy for a body to absorb, and by releasing sugar it renders even the blandest staples palatable. The malted grain is readily available, cheap, and safe to eat. It should develop healthy bodies and fully functioning brains in the millions of children whose health and happiness is now jeopardized by malnutrition.

Of all the world's cereal grains, finger millet is second only to barley in its ability to hydrolyze starches ("malting power"). And it has the inestimable value of growing in the latitudes where malnutrition is rife. But for all its potential to benefit the malnourished, not much attention has been paid to malting internationally. The fact that malting is a cheap and widely understood process that can be easily accomplished in the home or village and requires no fuel or special equipment is a major benefit. This means that good quality weaning foods can be made by the poor, who cannot afford to buy commercial baby food concoctions.

Unit operations in malting process

The malting process involves soaking, germination, drying, de-rooting and kilning. Although, these unit operations are of importance with respect to the quality of malt, the germination process is the single most important step because, the hydrolytic enzymes developed brings endosperm modification. Besides, some of the vitamins are synthesized and the bioavailability of the minerals increases.

Dry malt milling process

Soaking millet for about 8-12 h is needed for increasing its moisture content to about 30%. It is desirable to change the soak water once or twice, to discard the leacheates to free it from the carbon-di-oxide formed and to prevent excessive growth of microorganisms. The

soaked grains are germinated in the incubator under controlled temperature and humidity. During germination, it is essential to mix and overturn the material to dissipate heat

developed and also to provide good aeration to the sprouts. Normally, germination up to 48 hr is desirable, but in summer, the germination period can be reduced to 24-36 h. The protease and cell wall degrading enzymes developed during germination, partially digest the cell walls. On the other hand, the amylases digest the starch to some extent. Hence, the malted ragi will have softer endosperm texture.

To stop the germination process, the sprouts are dried either in sun or mechanically. In case of mechanical drying, the air temperature should not exceed 75°C; as otherwise it will impart parboiling effect and hardens the grain, affecting its milling as well as food qualities.

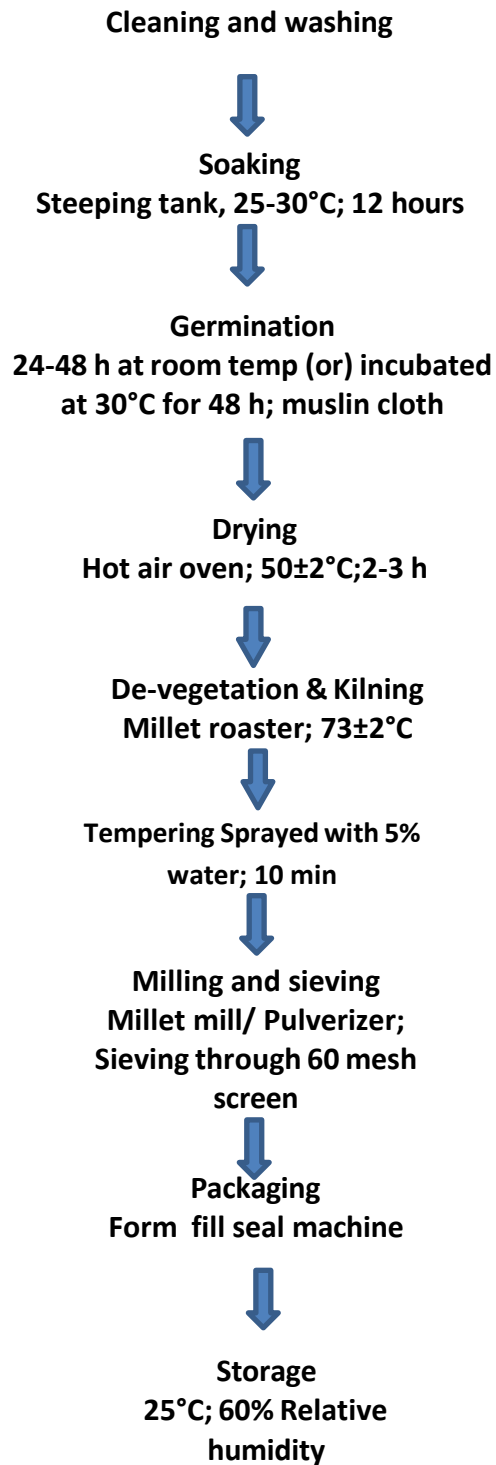
Sun drying the sprouts for 5-6 h will dehydrate to 12-14% moisture level. Subsequently, the root and shoots from the dried sprouts are separated. De-rooting could be effected by gentle brushing or using fruit pulper or rice huller. The de-rooted malt is kilned or cured by toasting at about 70°C by exposing to hot air or in conventional toasting pan or in rotary heaters.

The product prepared in rotary heater develops better aroma with desirable qualities due to uniform exposure to contact heat. The malt is not a ready-to-eat product and needs further processing for various food uses. Conventionally, the malt is pulverized and sieved through the nylon or thin fine cloth to prepare malt flour free from husk. Alternately, the malt is milled and the whole meal is suspended in excess water, the starchy portion settled is collected and dried.

The malt flour thus prepared (either by sieving or by drying the settled material) is used for infant feeding and also as a base for the milk based beverage. Both the above said methods have drawbacks; in the former method, the yield of the malt flour is poor and hardly 35-40% whereas in the later method, the soluble nutrients from the malt such as amino acids, free sugars, vitamins and minerals are lost along with the discarded water.

To avoid the drawback in the above two methods, tempering of malted grain performed. It consists of mixing the malt with 5-7% additional water just to wet the surface of the grains and then pulverized. Then, the meal is sieved through a fine mesh to separate out the seed coat as coarse flakes. Addition of water imparts rubbery texture to the seed coat and minimizes its pulverisibility and because of that, most of it is separated as coarse flaky bran. Normally, the yield of good quality husk free flour prepared following this process is about 65% on the malted grain basis.

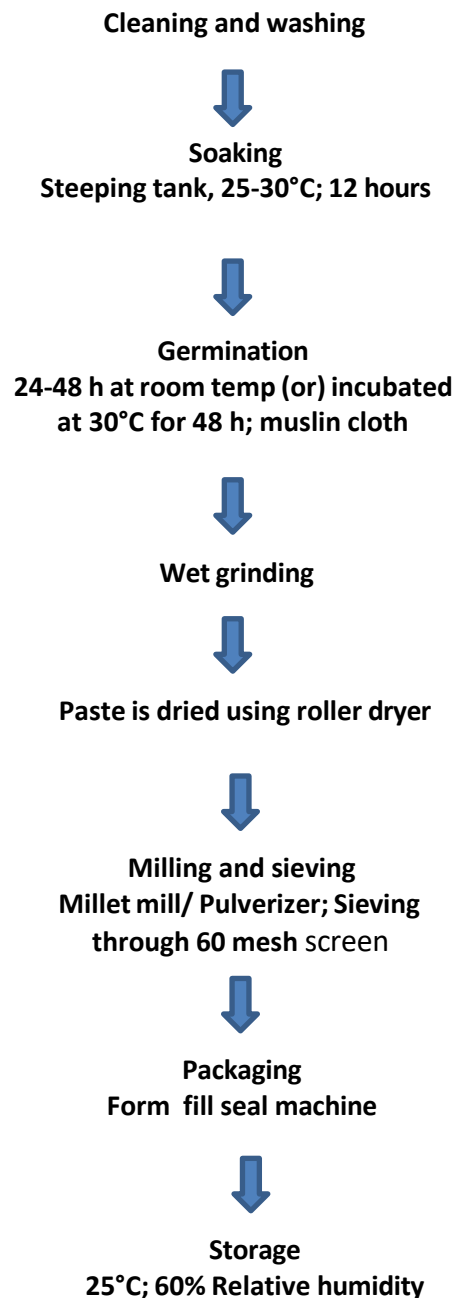
Flow chart for malting of finger millet Dry method



Malting of finger millet wet method

Soaking and germination process are as same as in the dry method. Once the grains are germinated the grains are ground in to a fine paste. The paste is dried using twin roller dryer and dries flakes are pulverized using pulveriser then sieved and packed.

Flow chart malting finger millet - wet method



Changed during malting process

Germination of finger millet is the most familiar method in India and nutrition profile of germinated finger millet is measured better than germinated maize and germinated sorghum. Amylase activity (AC) of finger millet is higher than sorghum and other millets which take 4-5 days to reach to maximum AC. Germination protects the grains from fungal infection and has dominant effect on number of biochemical changes which enhances the nutritional value of malted products. It leads to expansion of α and β -amylase throughout germination process, which develops desirable aroma during roasting/kilning and makes it a supreme grain for malt foods.

Germination, malting and sprouting are the most commonly used terms to pass on to the method of soaking. Apart from enhancing the nutrients value, germination also helps to lowers down the antinutritional content of finger millet as tannin, phytic acid and trypsin inhibitors activity (TIA) which drastically improves bio accessibility of dietary minerals such as zinc, iron and calcium.

Malting and germination resulted in a significant improvement in protein content. Malting of finger millet carried out at 48h/30°C increase the protein content by 25%. Malting also improves the Protein Efficiency Ratio (PER) of finger millet.

Application of finger millet malt food

Finger millet malt food finds its major application as

1. Weaning/ complementary food
2. Amylase rich food.

Weaning food

Adequate nutrition during infant stage is crucial for healthy development and growth of child. Infancy period (0-2 years) is a “critical window” for promotion of optimal growth, health and behavioural development. There is a need for nutritionally balanced, energy dense, easily digestible foods along with functional benefits, to be formulated. Weaning/ complementary foods, introduced to children between the ages of 6 months to 3 years, are liquids and semisolids, which are later replaced by solid foods. In addition to providing adequate nutrition, weaning foods should possess proper functional properties. According to WHO, good quality weaning food must have high nutrient density, low bulk density, low viscosity and appropriate texture along with high energy, protein and micronutrient contents and have a consistency that allows easy consumption. Most of the weaning foods are incorporated with wheat, which causes food allergies, celiac diseases and other allergies like asthma, stomach cramp, hay fever etc. So, it is the need to develop the weaning food by

replacing the wheat with some other easily digestible and fiber containing food ingredients. Millets are nutritionally comparable to major cereals and serve as good source of protein, micronutrients and phytochemicals. Millets are rich source of Sulphur containing amino acids, Vitamin B and in certain minerals like magnesium, manganese, iron, copper, phosphorous and zinc.

The Indian Academy of Pediatrics, after a careful consideration of all the factors involved, recommends that the optimal time for introducing solid foods into the infant's diet is 4 to 6 months of age. The semisolid foods given to the child at this stage are generally called weaning foods. Weaning foods are adult foods, modified by processing the ingredients to make them easily digestible by the infant. Suitable first weaning foods include vegetable and fruit purees, non-wheat cereals as porridge enriched with oil/fat, and unsweetened yogurt. Sugar can be sparingly used (can be avoided) while salt should not be used. Current guidelines recommend that cereals given to infants less than six months old should preferably be gluten-free. A nutritionally adequate weaning diet is essential for achieving optimal growth in the first year. Growth in the first year influences both the well-being of the child and the long-term health of the adult. During complementary feeding phase, porridges or gruels are fed to infants. These tend to have a high viscosity and low energy content, which may not meet the daily energy requirements of the child. This may result in malnutrition of the child.

The finger millet malt food can be mixed with powdered sugar, milk powder and flavouring agents such as cardamom to use as milk based beverage, which is popularly sold as "ragi malt" in Southern India. Since, the malt flour contains hardly 3-5% protein, it can be blended with vegetable or animal protein source such as grain legumes, milk powder, egg powder etc., to prepare supplementary nutritious food for children. Now a days, about 5% ragi malt is invariably blended with the energy food to improve its texture. This food is produced on bulk and supplied to the weaning children. The process for preparation of weaning food based on malted millet (two parts) blended with malted green gram (one part) and the food is popularly termed as "Malted Weaning Food" (MWF). Controlled child feeding trials on the MWF have shown its superior nutritional and textural qualities compared to several proprietary weaning foods. The food on reconstitution with water and heating to boiling, forms nutrient dense slurry (low bulk) and under comparable consistency, the MWF contains twice the amount of nutrients than the roller dried weaning foods. The malt flour as a substitute to maltodextrin, can be blended with milk and spray dried to prepare the infant food also.

Amylose Rich Food (ARF)

Amylase Rich Food (ARF) is the scientific name given to flours of malted grains and must be utilized in infant foods. Just tiny or catalytic amounts of any germinated cereal flour can instantly liquefy or reduce the dietary bulk of viscous mixed cereal based gruel. The flours are rich in α -amylase which can break long carbohydrate chains into shorter dextrins. Malting reduces the viscosity of foods and hence a child can eat more at a time. Flours of malted food when mixed with other foods help in reducing the viscosity of that food

In most developing countries the first food to get a place in a child's diet is a porridge prepared from a cereal or cereal flour. These porridges are characterized by high viscosity and low energy density (energy content per unit volume of food), necessitating frequent feedings to the child to meet daily energy requirements.

Such viscous low energy foods can be transformed into low bulk, high-energy porridges by just adding a pinch of Amylose Rich Flour (ARF) to a big cup of hot cooked porridge. ARF is germinated cereal flours rich in the enzyme α -amylase. Just tiny or catalytic amounts of any germinated cereal flour can instantly liquefy and reduce the dietary bulk of viscous cereal based or mixed gruels. The α -amylase breaks down the long chain of complex carbohydrates into simple glucoses. The concept of ARF directly addresses the twin problems of dietary bulk and poor energy density of most of the weaning gruels. This property makes it possible to offer the weaning child a low viscous yet high energy dense food prepared from the practical household ingredients, even in economically weaker households.

The most unique advantage of ARF is that a mother can add in much more ARF into a gruel and consequently make it even more high energy dense, while lowering viscosity and dietary bulk. Around 100gm of ARF can suffice one child's gruel feeds for one month. The big advantages of ARF are its inexpensiveness and simple technology. The addition of ARF to the weaning food can be done during the preparation of the slurry; alternatively the malt flour could be mixed with dry food (cereal-pulse based) and packed.

The inclusion of ARF in infant food

- **lowers the dietary bulk** thus making the porridge easier to consume
- **increases the energy density** i.e calorie content per unit volume of food consumed.

The malt flour is a good source of nutrients besides, serves as a source of amylases and hence termed as "Amylase Rich Food" (ARF).

Packaging of malt food from finger millet

The packaging must contain and preserve a certain quantity of product as efficiently as possible and also must protect its contents from external threats including spoilage, breakage, damage from external environmental conditions, pilfering and theft. Primary, secondary and tertiary packaging must be designed so that the product stays in perfect condition until it reaches the end user. The package must be strong and durable enough to protect the product with a reasonable safety margin.

Choosing packaging materials for cereal products should be related to the major indices of failure of cereals, which include loss of crispness, lipid oxidation, and nutrient loss, etc. Weaning food based on cereal is highly sensitive to changes in moisture, resulting in caking when the relative humidity exceeds 60%. For instance, at higher moisture the product turns bitter owing to hydrolytic rancidity.

The packaging material should be

- able to withstand mechanical hazards during transportation and facilitate stacking several tiers high so as to optimize the use of available space.
- able to protect the contents from spillage.
- able to protect the contents from insect infestation.
- able to protect from external odor.
- easy to handle.
- economical and easily available.

Bulk packaging

Plastic woven sacks

Flat or circular woven plastic sacks of poly propylene or HDPE with suitable poly ethylene layer can be used for cereal flour. They provide good protection at high humidity economically. Up to 100kg product can be packed in them.

Multiwall paper sacks

For storage of flour below 86% relative humidity, paper bags made of 3-7 plies of kraft, union kraft or extensible kraft are generally used to hold upto 50kg capacity. Laminating them further with PE/ PP/aluminium foil lining would further increase their utility.

Retail Packaging

Retail packaging is the key to successful marketing of modern food products. It goes beyond eye appeal, convenience in size, shape and ease of opening. The product is to be protected against infestation, contamination, entry of oxygen and moisture.

The main function of the unit packages for cereal flours is containment of a measured quantity. As the bulk density of these products is high, packaging material needs to have good impact strength and good tensile strength for working on FFS machines.

Metal containers

Metal containers are one of the most exquisite packaging materials that are easy to carry, close, reuse, and recycle. Three types of metal containers are in the market - aluminium, tin coated steel (tinplate) and electrolytic chromium coated steel (ECCS). Many foods are photo-sensitive; sunlight damages their appearance and worsens their taste. Aluminium cans solve this problem in the best way possible which is why it is generally regarded as the ideal core packaging material for food. Aluminium cans are most commonly used for cereal based products and malted milk powder.

Though metal containers have perfect gas barrier properties, convenience, and extreme strength, they are selectively used for cereal products due to their cost.

Bag in box

Microflute corrugated paperboards have unique characteristics including good strength properties, excellent shock absorbing ability, good aesthetic appearance, environmental advantages, and distinctive print properties. White board is suitable for contact with food and is often coated with low density polyethylene (LDPE), poly vinyl chloride (PVC), or wax. Different types of cereal based products are packed in paper based materials. The major products include weaning foods and breakfast cereals.

Flexible films

Flexible plastic films have been used for cereals in single packaging or multi-serving size packages with other packaging materials. Biaxially oriented films are most widely used, as it has qualities of toughness (against puncture and abrasion) and clarity, and is rendered heat sealable by coextrusion or coating with polyolefin copolymers. Films are also coated with other polymers or aluminum to improve the barrier properties or to impart heat sealability.

Other films include: LDPE/LLDPE films, High Molecular High Density Polyethylene films. Laminates made from BOPP/LDPE, Cast Polypropylene (CPP)/LDPE, Polyester/

LDPE are used in few branded commodities. These laminates apart from protecting flavour loss and rancidity, retards insect infestation, prevents pick up of foreign odours and offers excellent printing surface. Aluminium coated (in the range of 0.5 micrometers) BOPP or PET are also widely used.

Standup Pouches

Stand up pouch packaging is the modern version of flexible packaging. Standup pouches are easy to use, less messy, shatterproof and easy to handle. The style of this packaging is mainly in a box form. The pouch has a very flat bottom surface and when it is filled it balances straight up, unaccompanied. The pouch also has left and right side gussets. Material forms used during the production process of these bags include PET, BOPP, PE or aluminum foil. All these materials contribute to the durability and flexibility of stand up pouch bag packaging designs. The thickness and capacity of packaging material depends upon type of product.

Stand up pouches made of metallized polyester (Aluminium coated over PET) are also widely used as 3 layer packaging pouch layered between PET and PE as they possess moisture barrier, heat sealable, high glossy and flavor barrier properties. Usually provided with zip, these are finding more appeal in terms of presentation and convenience.

More recently kraft paper bags are seen more food packaging. Kraft paper bags are made by sulphate pulping process and coated/ laminated with polyamide or poly amine resin to improve barrier properties. This material has several advantages like good strength, printability and appearance, low cost, wide availability and low weight.

Packaging machine

The vertical form fill seal (VFFS) machine is generally used for packaging of flour. In VFFS machine the film enters a forming tube assembly. As it crests the shoulder (collar) on the forming tube, it is folded around the tube so that the end result is a length of film with the two outer edges of the film overlapping each other. This is the beginning of the bag forming process. The forming tube can be set up to make a lap seal or fin seal. A lap seal overlaps the two outer edges of the film to create a flat seal, while a fin seal marries the insides of the two outer edge of film to create a seal that sticks out, like a fin. A lap seal is generally considered more aesthetically pleasing and uses less material than a fin seal.

A rotary encoder is placed near the shoulder (collar) of the forming tube. The moving film in contact with the encoder wheel drives it. A pulse is generated for every length of movement, and this is transferred to the PLC (programmable logic controller). The bag length setting is set on the HMI (human machine interface) screen as a number and once this setting

is reached the film transport stops.

The film is drawn down by two gear motors which drive the friction pull-down belts located on either side of the forming tube. Pull down belts that utilize vacuum suction to grip the packaging film can be substituted for friction belts if desired. Friction belts are often recommended for dusty products as they experience less wear.

Bag Filling and Sealing

Now the film will briefly pause so the formed bag can receive its vertical seal. The vertical seal bar, which is hot, moves forward and makes contact with the vertical overlap on the film, bonding the layers of film together. The vertical sealing mechanism remains in contact with the film continuously so the film does not need to stop to receive its vertical seam.

Next, a set of heated horizontal sealing jaws come together to make the top seal of one bag and the bottom seal of the next bag. For intermittent VFFS packaging machines, the film comes to a stop to receive its horizontal seal from jaws that move in an open-close motion. For continuous motion packaging machines, the jaws themselves move in up-down and an open-close motion to seal the film as it is moving. Some continuous motion machines even have two sets of sealing jaws for added speed.

While the sealing jaws are closed, the product that is being packaged is dropped down the middle of the hollow forming tube and filled into the bag. A filling apparatus like a multi-head scale or auger filler is responsible for the correct measurement and release of discrete quantities of product to be dropped into each bag. These fillers are not a standard part of a VFFS packaging machine and must be purchased in addition to the machine itself. Most businesses integrate filler with their packaging machine.

Bag Discharge

After the product has been released into the bag, a sharp knife within the heat seal jaws moves forward and cuts the bag. The jaw opens and the packaged bag drops. This is the end of one cycle on a vertical packing machine. Depending upon the machine and bag type, VFFS equipment can complete between 30 and 300 of these cycles per minute.

Horizontal Form fill seal machine

In case of Horizontal Form Fill Seal Machines, the machine operation is Intermittent. Plastic laminated film is drawn off a supply reel by a pair of rollers. The reel passes over a folding plough which folds it into half. Vertical and bottom seals are made in accordance with the size of the pouch required. Each pouch gets separated from the web by a cutter and is transferred to the rotary turret. Each Pouch is held by a pair of grippers while being passed

from station to station which comprises of pouch opening, Product filling, final top sealing and then discharge onto the conveyor for product boxing and shipping processes.

Pouch filling machine

Pouch filling machine performs filling and sealing pre-shaped flat bags or stand up pouches. The foundation of the machine is an intermitting, rotating carousel. Grips are attached to this carousel from which the pre-formed bags are hanging. The rotation of the carousel makes sure the bag passes different stations where a specific action takes place, such as opening the bag, filling it and sealing it.

FSSAI standards and guidelines for malted food

MALT BASED FOODS (MALT FOOD) means the product obtained by mixing malt (wort or flour or malt extract) of any kind obtained by controlled germination of seeds (cereals and/or grain legumes), involving mainly steeping germination and kiln drying processes with other cereal and legume flour with or without whole milk or milk powder, flavouring agents, spices, emulsifying agents, eggs, egg powder, protein isolates, protein hydrolysates, edible common salt, liquid glucose, sodium or potassium bicarbonate minerals, amino acids and vitamins. It may contain added sugar and/or cocoa powder and processed in such a manner to secure partial or complete hydrolysis of starchy material in the form of powder or granules or flakes by drying or by dry mixing of the ingredients. The grains, legumes and their products used in preparation of malt shall be sound, uninfested and free from insect fragments, rat excreta, fungal infested grains or any other type of insect or fungal damage.

Particulars	Value
(a) Moisture	Not more than 5 per cent, by weight
(b) Total Protein (N x 6.25) (on dry basis)	Not less than 7.0 per cent, by weight
(c) Total ash (on dry basis)	Not more than 5 per cent, by weight
(d) Acid insoluble ash (in dilute HCl)	Not more than 0.1 per cent, by weight
(e) Total plate count	Not more than 50,000 per gram.
(f) Coliform count	Not more than 10 per gram.
(g) Yeast and Mould Count	Not more than 100 per gram.
(h) E Coli	Absent in 10 gram.
(i) Salmonella and Shigella	Absent in 25 gram
(j) Alcoholic Acidity	Not more than 0.30 per cent. (expressed as H ₂ SO ₄) with 90 per cent alcohol (on dry weight basis
(k) Vibrio cholera and V.Parahaemolyticus	absent in 0.1 gm
(l) Faecal streptococci and Staphylococcus aureas	absent in 0.1 gm

Manufacturers List of Food Processing Machineries

S.no	Name of the company	Machineries
1.	Pawana engineering projects pvt.ltd. Pune - 411019, INDIA Tel No. 20 - 27472503 / 9822339774	Spray dryer
2.	Acmeofil Engineering Systems Private Limited Plot No. 535, Phase II, GIDC Vatwa, Ahmedabad - 382445, Gujarat, India	Spray dryer
3.	Excel Plants & Equipment Private Limited, Gat No. 611, Mouje Kuruli, M. I. D. C. Chakan, Pune - 410501, Maharashtra, India	Spray dryer
4.	Sai Enterprises 2, Bharat Compd., B/h.Sahara Hotel, Opp.Pravasi I.E., Goregaon (E), Mumbai-400063 9820062413 / 9320062413 www.sailabequipment.com	Tray dryer, ball mill, incubator
5.	Accelor Food Tech Pvt Ltd 22, RVL Nagar, Uppilipalayam Post, Coimbatore – 641 015, Tamil Nadu, India. +91 – 99944-11095 info@accelorfoodtech.com	Washer, tray dryer
6.	Industrial Laboratory PB.No:6063, No:38, 1st Floor, 2nd Street Anjugam, 5 No. Gam Jafer Kabent Chennai, TamilNadu, India. Mobile No: +91- 9840836548	Tray drier

7.	Pilot smith Pvt Ltd Kallettumkara, Trichur District Kerala, IndiaPIN : 680 683 mech@pilotsmithindia.com +91 480 - 2881908, 2881157	Roaster and milling equipment, pulveriser Washing and soaking equipment
8.	The Pattish Enterprises No. 434-435, Dr. Nanjappa Road, Ram Nagar Coimbatore - 641018, Tamil Nadu, India	Millet roaster
9.	Zigma International SF. No. 25, Veerakeralam (Po), Vedapatti Road, Coimbatore - 641007, Tamil Nadu, India	Millet roaster, pulverizer
10.	SP Automation And Packagiing Machines 64, Athipalayam Rd, Ramakrishnapuram, Chinnavedampatti, Coimbatore, Tamil Nadu 641006	FFS machine
11.	Royal Pack Industries Gala No. 43 , Universal Industrial Estate, Ground Floor, Goregaon East, I.B. Patel Road Mumbai - 400063, Maharashtra, India	Packaging machinery and coding
12.	ACE Pack Machines 23, V. N. Industrial Estate, Bharathi Colony Rd, Sri Kamadhenu Nagar, Tamil Nadu 641004	FFS machine
13.	IPK Packaging (India) Private Limited Chinnavedampatti, Coimbatore, Tamil Nadu	Automatic standup Pouch Packing Machine.

14.	Unimech Industries 5401/A,Phase-4,Nr Ramol Crossing, Gidc Vatva, Vatva, Ahmedabad - 382445, Gujarat, India 09099087129	Drum or roller dryer
15.	Laxmi En-fab Private Limited, No. 25, Nilsin Plot, Phase I , GIDC Vatwa, Ahmedabad, Gujarat	Drum/roller dryer
16.	Aum Enggiserve and Pharmachem Limited, Dashrath, Vadodara, Gujarat	Drum/ roller dryer
17.	Murhopye Scientific Company, B-11, Metagalli Industrial Estate, Metagalli Mysore - 576016, Mysuru, Karnataka, India	Drum/ roller dryer
18.	N.N. Engineering Products 66/2, Athipalayam road, Chinnavedampatti, Coimbatore, Tamil Nadu 641049. 91-422-2332179 / 4376179	Millet cleaning machinery & destoner
19.	Fowler Westrup (India) Private Limited KIADB Industrial Area, Malur, Kolar, Karnataka	Millet cleaning machinery & destoner

20.	Universal Engineers 36/6, Gali No. 3, Rajendar Nagar Industrial Area, Rajendra Nagar Ghaziabad - 201007, Uttar Pradesh, India	Fruit pulper for de-vegetation
21.	Economy Engineering Company Kirti Building Dr V B Gandhi Marg, Fort, Mumbai-400001, Maharashtra, India	Fruit pulper for de-vegetation



Contact Us

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