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Case Study

Processing and Value Addition of Finger Millet to Achieve Nutritional and Financial Security

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A B S T R A C T

Millets are traditionally grown by resource poor farmers in various 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 fiber content which includes protein, essential fatty acids, 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 with 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. Hence developing technology that makes millet value added products available as convenient to make and easy access at reasonable prices may create great demand and have market particularly in urban places, where there is growing conscious for intake of nutritive food. Finger millet is in food use since time immemorial, and large number of traditional food preparations is in practice in the rural areas (predominantly tribal areas), particularly in the production catchments. Finger millet also known as ragi in India is one of the important cereals which occupies highest area under cultivation among the small millets. Finger millet is comparable to rice with regard to protein (6-8%) and fat (1-2%) and is superior to rice and wheat with respect to mineral, fibre and micronutrient contents. It could be a major source of dietary carbohydrates for a large section of society. However, its utilization in the daily dietary at present is very limited in rural areas/tribal areas only. Unavailability of products to the taste of urban community is the main reason. Processing the finger millet using traditional as well as modern techniques for the development of value added and convenient food products would be the possible solution for its promotion and enhancement of consumption, and thereby increasing profitability and better livelihood to the rural community. This will also help the country to diversify the food basket for nutritional contents and sustainable food availability to the common mass with low purchasing capacity. The present paper describes some of the possible value added products from finger millet and deals with the presence of many vital nutrients and other health promoters in Ragi.

Keywords

Millet, millet processing, value addition and traditional food, nutri cereals

Introduction

Millets are one of the oldest food grains known to mankind and possibly the first cereal grain used for domestic purposes. For centuries, millets have been a prized crop in India and are staple diet for nearly 1/3rd of the world's population. They can adapt themselves to marginal soils and varied environmental conditions.

Over 60% of world's total protein and calories are provided by only three crops – rice, wheat and maize. Our food security, with such a high dependence on these narrow food-base, faces and will face high risk owing to growing uncertainties in the climate and emergence of new biotic and abiotic stresses. Consequently, there is a global concern to collect, introduce, evaluate and utilize vast array of lesser known, under-exploited, alternative crop-plants for diversifying agricultural systems. Millet crop 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. India is the leading producer of small millets namely, finger millet (*ragi*), kodo millet (*kodo*), foxtail millet (*kangni*), barnyard millet (*sawan*), proso millet(*cheema*) and little millet (*kutki*).

At present, small millets account for less than 1% of food grains produced in the world (ICAR, 2010). Their cultivation dates back to nearly 5000 years, and in India, they form an important component of the traditional cropping systems and contribute significantly to the regional food and nutritional security. Area under finger millet has declined but with the significant diversity in the national food basket; and they are important in areas of their production as dryland crops, as well as for hill agriculture. The small millet grains have longer storage life, and can be termed as famine reserve.

Cereals form a major portion of human diet and are an important source of starch and other dietary carbohydrates (dietary fibre), which play an important role in the energy requirement and nutrient intake of human. The Finger millet is with higher fibre content, and their protein quality and mineral composition contribute significantly to nutritional security of a large section of population residing in the millet growing areas, considered to be the most disadvantaged groups. Finger millets are most recognized nutritionally for being a good source of minerals like magnesium, manganese and phosphorus. Research has linked magnesium to reduce risk for heart attack and phosphorus is important for the development of body tissue and energy metabolism. Finger millets are also rich in phytochemicals, including phytic acid, which is believed to lower cholesterol, and phytate, which is associated with reduced cancer risk. Thus, millets are strategic in terms of their food, nutritional and livelihood security and their role in local agro-ecosystems. 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.

Food uses of millets have, however, been confined only to traditional consumers; limited especially to areas of their cultivation, and still have remained underutilized. Processing them using traditional as well as contemporary methods for preparation of value added and convenience products would certainly diversify their food uses. Their exploitation for preparation of ready-to-use or ready-to-cook and eat products would help in increasing the consumption of millets among non-millet consumers. The present paper is an attempt to describe some basic information about finger millet, the processing requirement and some avenue for its value addition and food uses. Finger millet (*ragi*) is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The

calcium content is higher than all the cereals and iodine content is said to be highest among all the food grains (Desai *et al.,* 2010). *Ragi* has best quality protein along with the presence of essential amino acids, vitamin A, vitamin B and phosphorus (Gopalan *et al.,* 2004). Finger millet (*ragi*) provides highest of level of calcium, antioxidants properties, phytochemicals, which make it easily and slowly digestible. Hence it helps to control blood glucose levels in diabetic patients very efficiently.

Materials and Methods

The study was done in Ranchi district of Jharkhand, as a part of KVK Program. Need for developing technologies for processing of finger millet was felt during survey of villages by PRA methods and also during other meetings in villages. The Production of millets was decreasing due to unavailability of suitable processing technologies, villagers who were habitual to take millets in their diet had also changed their food habit and shifted to more refined cereals as staple food. In order to develop suitable technologies for ragi processing, the on station trials were conducted in KVK food processing lab. After so many trials, the technologies developed and standardized. Farm women already trained in food processing were involved in developing farmer friendly low cost methods of Ragi processing.

Major Findings

Finger millet can be used in a variety of ways and is a great substitute for other grains such as rice and other starchy grains. The commonly used processing technologies f or Finger millet are milling, malting, baking, fermenting and combination of methods for product development. These products are either in practice or have been demonstrated as avenue for enhanced consumption of finger millet. However, not much scientific studies have been carried out about their preparation and meaningful popularization on large scale, but technologies developed for value added products are widely accepted among farming communities and also recognized by various research institutes and agricultural universities.

Nutritional composition of finger millet

Like other cereals grains small millets are predominantly starchy. The protein content is more or less equal and comparable to that of wheat, rice and maize. Finger millet has slightly lower protein content but is in fact nutritionally superior because the protein quality is generally as good as or better than other cereals. Finger millet contains lowest fat. One of the characteristic features of the grain congestion of millet is their high ash content (mineral composition). They are relatively rich in iron and phosphorus. Finger millet has the highest calcium content (344mg/100 g) among all the food grains. High fibre content and lower digestibility of nutrients is the other characteristic feature of millet grains.

The nutritional composition of small millets has been reported and published at many places by researchers. However, an average nutritional composition of finger millet along with other cereals is being shown in the table.

Table also gives the comparison of properties of these millets with two major cereals of the world, wheat and rice. From the Table 1, it is clearly seen that the *ragi* millet is nutritionally superior compared to other three crops. *Ragi* millet contains fibre, more mineral and more vitamins, which are normally deficient in

Indian diet and has eight times more calcium than other cereals. It is comparable to rice with regard to protein (6-8%) and fat (1-2%) and is superior to rice and wheat with respect to mineral and micronutrient contents. The three minerals iron, calcium and phosphorus are of nutritional importance in the diets of population who consume millet as staple food. It is a major source of dietary carbohydrates for a large section of society belonging to millet growing areas. In addition to these, millets contain few other micro-nutrient compounds such as lignin, manganese, niacin etc. which are also important for human diet.

Effect of millets on health

Magnesium from millets not only help to reduce the severity of asthma and migraine attacks, but also helps to reduce high blood pressure, diabetic heart disease, atherosclerosis and heart attack. Niacin is being used since ages to reduce high cholesterol levels in the body (Guigliano *et al.,* 2011). Phosphorus from millets is an important mineral for energy production and is an essential component of Adenosine Triphosphate (ATP) – the energy store of the body (Shashi *et al.,* 2007). It also forms an essential part of nervous system and cell membranes. A cooked cup of millet provides 26.4% daily value for magnesium and 24% daily value for phosphorus. Magnesium from millets also helps to relax blood vessels, enhances nutrient delivery by improving the blood flow and maintains the blood pressure and thus further protects the cardiovascular system. Lignin present in millets is converted to mammalian lignans by the healthy gut micro flora in our body which is thought to protect against breast cancer as well as heart diseases. The insoluble fiber from millets helps in gallstones prevention. A study proved that including insoluble fiber in diet lowers the risk of getting gallstones by 17% compared to women whose diet lack in fiber. This gallstones protection from fiber is dose related, with every 5g increase in insoluble fiber the risk drops by 10%. Millets helps to lower blood glucose levels and improves insulin response (Lakshmi *et al.,* 2002). Finger millet is a humble grain with low glycemic index which makes it more suitable for diabetic patients **(**Pradhan *et al.,* 2008). They maintain the sugar level of diabetic patient. Additionally, it is a rich source of calcium (344 mg/100g) and helps in supplementing the calcium in human body. Postmenopausal women with signs of cardiovascular disease like high blood pressure, increased cholesterol and obesity can benefit from eating whole grains especially millets by eating them 6 times a week. Whole grains like millet may have health promoting effects equal to or even in higher amount than fruits and vegetables and have a protective effect against insulin resistance, heart diseases, diabetes, is chemic stroke, obesity, breast cancer, childhood asthma and premature death (Cade *et al.,* 2007).

Processing and value addition

Similar to other cereal grains finger millet is also required to undergo certain basic steps of primary processing operations, such as cleaning, grading and separation where in removal of unwanted materials like, stones, soil particles, stalks, chaffs, grains of other crops etc. These operations are also important for adding value to the produce from the point of view of getting better returns from their sale. The finger millet grain is essentially covered with an outer thin pericarp known as glume which needs to be removed from the kernel prior to further processing as it is non-edible tissue. Glume is separated by giving mild abrasive action with the help of hand or foot

pounding operation. This is also possible with the help of hullers used for de husking of paddy. Specially designed ragi polishers are also used for this purpose in southern part of India. Pre-cleaning operations are accomplished by using cleaners and de stoners used for other cereals after making suitable modifications.

Milling

The most common primary processing of finger millet is to convert the grain in the form of flour which is achieved by pulverizing or milling. Different types of conventional and modern equipment's/machines are available for milling the finger millet grains into flour. Some of them are; conventional stone mills, burr mills (steel or emery type), hammer mills, ball mills, small pulverizes etc. Since the whole meal is used for different preparations, the fineness of the flour or the machine by which it is prepared does not arise. On demand of the recipe the coarser flour is separated by sieving the whole meal.

Till date, no scientific definition about the millet flour for traditional preparations like chapatti (*roti*), mudde of Karnataka, *pez* of Bastar *etc.* has been established. However, finer flour is preferred for making chapatti whereas comparatively coarser flour is suitable for *laddu* and other preparations. coarser flour helps in lump formation during laddu preparation and that of finer flour absorbs more water due to higher surface area and facilitates flattering for chapatti making. In recent years the consumption of finger mill*et al.,*ong with other millets has been increased particularly in the urban sector due to awareness about the inherent nutritional and medicinal properties of millets. Looking to the growing demand of ready-to-eat and ready-to-cook products, there is a need exists to prepare the millet flour suitable for different traditional food products. Fortified ready mixes for the conventional preparation of popular traditional foods combining finger millet (ragi) as one of the ingredients are available in the market which further encourages for milling of ragi into flour. Millet is gluten-free and safe to eat for those who experience gluten sensitivity.

Technologies for Finger millet value added products preparation

Nutritive Laddus

It may be prepared by using millets with other nutritive ingredients. Technology have been developed at Divyayan KVK Ranchi in convergence with Birsa Agricultural University, kanke, Ranchi with the objective of providing multi nutrients in low cost for the tribal communities. It comprises ingredients from almost all important food group i.e cereal (millets), pulses, nuts and fats with sweeteners it is nutritionally dense with protein, minerals, vitamins and antioxidants which makes it as healthy substitute of traditional or conventional laddus. It has good flavor and long shelf life. It contains no artificial flavor or preservatives. It is easy to make and can be stored without much packaging.

Ingredients

Ragi flour- 50 gm
Bengal gram flour- 50 gm
Ground nut-20gm
Dry fruits/ nuts-5 gm
Sugar – 70 gm
Ghee -90 gm

Method of preparation

Finger millet is cleaned and processed to make fine ragi flour.

Small amount of ragi flour is taken with equal amount of Bengal gram flour as main ingredient to make laddu.

After frying separately both ingredients in ghee or Vanaspati oil, it is mixed with ground nut powder and elaichi powder for flavor and nutrient enrichment.

Sugar is added with small quantity of water to make dense sugar syrup. Bhura, a sugar syrup product is obtained in solid form, which is then powdered to make sugar powder

Laddus are prepared after mixing it with sugar powder and other nuts/dry fruits. Ragi balls /Nutritive Laddus prepared by this method are having very pleasant taste and smell. It can also be made with honey/ jiggery for people who don't like to take refined sugar.

May be used by

Tribal/ Non-tribal farmer for achieving nutritional enterprise development.

Health and fitness club

Nutraceutical Industries

Aanganwadis and Midday meal Programmes

Financial Analysis

Fixed cost inclusive of depreciation and investment on fixed capital- 30000/-

Monthly operational expenses for an output of 3.75 ton- 60,955/-

Total cost of production Rs. - 200/ kg

Expected price Rs- 300/ kg

Expected net profit- Rs.100 / kg

Multi grain flour

The concept of multi-grain flour/composite flour is not new to the mankind. Mixing of two three types of grains or grain and pulses has been in practice since long ago depending upon the availability of such commodities locally or the food habits, but in such cases, the understanding of nutritional security is not necessarily linked. Multigrain flour by combining wheat and finger millet in the ratio of 7:3 (wheat: finger millet) is one of the simple semi-finished products suitable for making chapatti (roti), as no Indian meal is complete without Indian style bread or roti. In the proposed blend, though the gluten content is reduced significantly the making of chapatti while flattering is not affected. However, the colour of the chapatti turns to slightly dark. Fortification of finger millet in chapattis not only improves the taste but also helpful in controlling glucose levels in diabetic patients very efficiently (Kang *et al.,* 2008). The bulkiness of the fibres and the slower digestion rate makes us feel fuller on, fewer calories and therefore may help to prevent from eating excess calories. Its high fiber content is further helpful to the individuals having the problem of constipation (Cade *et al.,* 2007). A proportion of different grains and pulses mixed together to prepare a nutritive Multigrain flour suitable for chapati making.

Ingredients for Multigrain flour

Wheat -75 kg
Ragi -5kg
Bajra -5kg
Soyabean-5kg
Maize-5kg
Bangal gam dal-5kg

Method of Preparation

Cleaning the grains

Washing properly by rubbing with hand

Drying in sunlight

Pulverizing for getting fine flour

Packaging for marketing

Financial Analysis

Fixed cost inclusive of depreciation and investment on fixed capita 100000/-

Monthly operational expenses for an output of - 25000/-

Total cost of production -Rs. 45/ kg

Expected price-Rs70 / kg\

Expected net profit- Rs. 12,500 / month

Ragi Papad

Ingredient

Urad dal – 200 gm
Ragi flour – 200 gm
Salt – 15 gm
Papad Khar – 15 gm
Hing – 1 gm
Black Paper – 10 gm
Oil – 15 ml

Method of Preparation

Sieve both flours separately

Mix all ingredients

Make dough by mixing water in it

Leave for half an hour

Knead properly after mixing oil

Make papad by walling small ball at the dough

Dry the papad in sun and shadow.

Ragi Beverage

Ingredient

Ragi – 80 gms

Moong dal– 20 gms

Elaichi - 1 gms

Milk powder – 50 gms

Method of Preparation

Soak Ragi and Moong dal separately overnight

Next day put it for germination

Dry the germinated grains in sunlight and roast till aroma comes

Grind the roasted mixture so properly to get highly refined powder

Mix the milk powder and elaichi powder

Packed it in air tight jar

Mixed with hot water or milk and sugar to make a nutritive drink

Ragi Papad

Ingredient

Urad dal – 200 gm

Ragi flour – 200 gm
Salt – 15 gm
Papad Khar – 15 gm
Hing – 1 gm
Black Paper – 10 gm
Oil – 15 ml

Method of Preparation

Sieve both flours separately

Mix all ingredients

Make dough by mixing water in it

Leave the dough undisturbed for half an hour

Knead properly after mixing oil

Make papad by rolling small ball of the dough

Dry the papad in sun and pack properly.

Bakery Products from Finger millet

Ragi Cakes

Ragi cakes are a favorable dish for children. It is very tasty as well as have exhalent nutritive values.

It is very easy to prepare and had a good shelf life

Ingredients

Ragi flour - 50 gms
Maida - 50 gms
Ghee – 100 gms
Sugar – 100 gms
Egg – 4
Baking powder – 1 teaspoon
Vanilla essence -1/2 teaspoons

Method of Preparation

Mix the ragi flour Maida and Baking powder properly and sieve it 3-4 times

Mix powdered sugar and ghee together and with the mix sieved flour mixture and the it should be mixed properly.

Egg should be whipped and mixed in the mixture.

Vanilla essence should be added to mixture.

Baking of cake should be done at 200˚c in oven.

Non Khotai

Non khatai is type of biscuit which is prepared by baking of Ragi flour with wheat refined flour. It is suitable for sale after packaging as it has a very good taste and shelf life.

Ingredients

Ragi flour- 75 gm
Maida – 75 gm
Sugar – 115 gm
Ghee– 100 gm
Egg – 1 tablespoon
Baking powder – 1 teaspoon

Method of preparation

Mix Ragi flour, Maida and baking powder, properly and sieve it with fine siever 3- 4 times

Powdered sugar and ghee should be whipped together.

Mix egg and sieved flour together to make a dough for baking.

Prepare Small ball of dough in desired shape

and bake for 25-30 minutes on 150 c temperature.

Fermented Products of Finger millet

Ragi Idli

Fermented foods may also be prepared by mixing Ragi in equal amount with other grains and dal. Among fermented foods Idli and Dosa are very common as Breakfast food and even as main cafeteria food in some parts of country. Finger millet is widely used as one of the ingredients in such food in south India.

It not only improves the taste but at the same time enriches the food in terms of protein, calcium and fiber

Ingredients

Ragi – 1.5 bowl
Rice – 0.5 bowl
Urad dal – 1 bowl
Salt - taste based

Methods of preparation

Soak ragi, Rice and dal separately for 6-8 hours

Grind each soaked ingredient separately and mix properly. The mixture should be covered and left undisturbed for fermentation.

After mixing salt in fermented ingredients. The mixture is poured in idly stand for steaming.

Cook idlis in steam for 10 minutes.

The Ready to serve Idly are soft and fluffy having pleasant taste and flavor.

Ragi Dhokla

Ingredient

Ragi – 1 bowl

Bengal Gram dal – 1 bowl

Urad dal – 1 bowl

Curd – 1 bowl

Ginger green chilli paste – 2 tsp

Spices- Turmeric, Salt, Mustard seed, curry leaves, sugar and mustard oil

Method of Preparation

Soak Ragi, Urad and Bengal gram dal for 6-7 hours

Grind them separately and mix properly

Leave the mixture covered over night for fermentation

Mix curd with other ingredients and spices in the fermented mixture

Cook in steam for 15-20 minutes.

Heat oil in a fry pan and fry dhokla with mustard seed and curry leaves

Finger millet is well comparable and even superior to many cereals in terms of mineral and micronutrient contents. Its major use as food has remained only in the area where it is cultivated and to the traditional preparations. Finger millet has good potential of providing nutritional security to the consumers. Its consumption in urban area can be increased through its proper processing and value addition. With the advancement of post-harvest processing and value addition technologies, it has become possible to process and prepare value added products which are acceptable by both rural and urban consumers. This will not only help in increasing the profitability of its cultivators but will also help in providing income and employment opportunities in rural area.

Composition of *kodo* and *ragi* millets (per 100 g edible portion, 12% moisture content)

Particulars	Kodo	Ragi	Wheat	Rice
1. Carbohydrate (g)	66.6	72.6	71.2	78.2
2. Protein (g)	9.8	7.7	11.8	6.8
3. Fat (g)	1.3	1.5	1.5	0.5
4. Crude fibre (g)	9.0	3.6	12.9	5.2
5. Ash (g)	2.6	2.7	1.5	0.6
6. Calcium (mg)	27	344	41	10
7. Phosphorus (mg)	188	250	306	160
8. Iron (mg)	5.0	6.1	3.9	0.5
9. Manganese (mg)	3.3	3.5	13.3	1.0
10. Magnesium (mg)	228	130	120	32

Source: FAO.1970, Rome, Italy, Nutritive value of Indian foods, 1998, NIN, Hyderabad, India

Multi Nutrient laddu v/s Traditional laddu

Nutritive Laddu	Traditional Laddu
1. Nutritionally dense	1. Contains limited nutrients
2. Good antioxidant potential	2. Low antioxidant potential
3. Suitable for gluten allergic patients	3. It from is used can cause gluten allergy
4 Cost effective	4. High cost

References

Chetan, S. and Malleshi, N.G. 2007. "Finger millet polyphenols: optimization of extraction and effect of pH on their stability". Food Chemistry, Vol. 105, pp. 862-870.

Gopalan C, Ramashastri BV, Balasubramanian SC. Nutritive value of Indian Foods. NIN. Hyderabad. 2004, 47-91.

Hadimani, N.A. and Malleshi, N.G. 1993. "Studies on milling, physicochemical properties, nutrient composition and dietary fiber content of millets". Journal of Food Science and Technology, Vol. 30, pp. 17-20.

ICAR 2010. "ICAR News – a science and technology newsletter". Indian Council of Agricultural Research, New Delhi, India. Vol. 16(3): 16 p.

Nag, S. K., Mishra, N. K., Patel, S., Patil, S. K., Rao, S.S., Verma, P.K., Sahu, R. And Netam, R.S. 2011. "Empowerment to village entrepreneurship through tamarind – processing techniques". In: Engineering Interventions in Agriculture-The Way to Improve Rural Economy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, pp 608-610.

Pradhan, A, Nag, S.K. and Patil, S. K. 2009. "Dietary management of finger millet (*Eleusine coracana* L. Gaerth)". Current Science, Vol. 98, pp. 763-765.

Yenagi NB, Handigol JA, Bala Ravi S, Bhag Mal, Padulosi. Nutritional and technological advancements in the promotion of ethnic and novel foods using the genetic diversity of minor millets in India. Indian Journal of Plant Genetics Resources. 2010; 23(1):82-86.