

## Nutritional and Technological Advancements in the Promotion of Ethnic and Novel Foods Using the Genetic Diversity of Minor Millets in India

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An appropriate food processing technology stimulates agricultural production, ensures availability of quality products, value addition and helps in creating jobs and thus plays a crucial role in the economic progress and industrial development in the rural areas of India. The research on small or minor millet species was undertaken to explore the inherent technological opportunities for better utilization of resources in designing value added and sustainable foods in different sectors of food industries under the project “Value addition to nutritious millets to enhance food security and income of the rural poor” supported by International Fund for Agricultural Development (IFAD), Rome, Italy. The traditional fermented breakfast food ‘*paddu*’ made with little millet has light and fluffy textural quality of cooked starch and is highly acceptable for taste and texture as compared to that made with rice. Small seeded little millet showed an advantage over rice due to several technological features like less water uptake, less soaking, grinding, and baking time and high product yield. Introduction of *paddu* in restaurants was acceptable to the consumers and was found sustainable in hotels. Indigenous *papads* such as ‘*nera happala*’ and ‘*mudde happala*’ prepared from the gelatinized mass of three days soaked millets, viz., *ragi* (finger millet), little millet and foxtail millet without addition of any chemical additive like ‘*happla khara*’ enhanced the characteristic aroma and sour taste with good expansion of fried *papad*. *Papads* were highly acceptable for all the sensory attributes. This natural fermented food which is harmless to health has cost effective preparation and, requires less laborious technology. When taken as a home based food industry by women entrepreneurs of Jekinakatti village of Haveri district in Karnataka, it was found profitable as compared to black gram *dhal papad*. Incorporation of 50% whole grain foxtail millet or *ragi* flour to standard recipe with change in proportion of fat yielded acceptable cookies of different types with good spreading quality, crispy texture and sweet taste. Muffins of foxtail millet and *ragi* were light, puffy and highly acceptable for taste. Incorporation of millet flour in cookies and muffins increased the protein, fibre, and micronutrient contents. Millet based products showed good potential to enter bakery industry especially in rural sector as a nutritious snack item for school children. Thus, ethnic millet *papads*, fermented breakfast food ‘*paddu*’ and bakery products have good scope for marketing and income generation through rural women entrepreneurs. Value addition to millets is a highly strategic intervention in the popularization of nutritionally rich crops. As this project has demonstrated, the success and sustainability of efforts in this domain is closely dependant upon an effective synergy among highly complementary disciplines, including conservation of plant genetic resources, crop improvement, agronomy and marketing.

**Key Words:** Small millets, Food technology, Value addition, Ethnic and novel foods, Women empowerment

### Introduction

Neglected and underutilized crop genetic resources are very vital for sustainable agriculture (Eyzaguirre *et al.*, 1999, Bhag Mal, 2007) and minor millets belong to this important group of crops (Dutta *et al.*, 2007). Plant genetic resources play a critical role in enhancing adaptation and resilience of agricultural production systems (Jarvis *et al.*, 2007). The important minor millets cultivated in India are finger millet (*Eleusine coracana* (L.) Gaertner), kodo millet (*Paspalum scrobiculatum* L.), foxtail millet (*Setaria italica* (L.) Pal), little millet (*Panicum sumatrense* Roth ex Roemer & Schultes), proso millet (*Panicum miliaceum* L.) and barnyard millet (*Echinochloa colona* (L.) Link (Riley *et al.*, 1993). These millets have remained the food

for the people of the lower economic strata and traditional consumers, because of their coarse texture, characteristic flavour, intensely coloured seed coat and cultural attachments (Yenagi, 2004). However, the non-availability of processed products similar to rice or wheat is the primary reason for their consumption being confined to traditional consumers. Culture has preserved the significance of millets through the promulgation of their use in the preparation of traditional ethnic dishes during special occasions and rituals (Yenagi *et al.*, 2004). Ethnic foods made out of small millets have excellent taste, crispy texture, light and fluffy characteristics and superior textural quality of cooked starch. They are also highly acceptable for taste and texture by both rural and urban

consumers (Yenagi, 2005). The promotion of indigenous and value added products through different communication techniques enhanced the consumers knowledge and readiness to incorporate millets in their daily diet. An appropriate food processing technology stimulates agriculture production, ensures availability of quality products, value addition and helps in creating jobs. Such an approach is thus strategic in supporting both the economic progress and industrial development in rural areas of India (Yenagi, 2007). Because women are the main actors behind the knowledge, production and consumption of genetic resources of small millets, the enhanced use of these crops also provides an opportunity of empowerment of this marginalized sector of the Indian society. It is under this background that the IFAD funded research project on small millets is being pursued to explore the inherent technological opportunities for better utilization of these resources in designing value added and sustainable foods in different sectors of food industries in India.

### Material and Methods

#### *Selection of ethnic and novel foods*

Products, accepted by both rural and urban consumers across Karnataka State and which have entered the entrepreneurial activities of women Self Help Groups (SHGs) as home based food processing activity, were selected for evaluation of nutritional and technological opportunities for better utilization in the market as compared to other products already existing in the market. Ethnic foods like *mudde happala* and fermented breakfast food - *paddu* and novel foods such as biscuits, *chakali* and *laddoos* were selected.

#### **Evaluation of Ethnic and Novel Foods of Millets for Technological and Nutritional Qualities**

**Technological properties:** The observations were recorded on weight of the dough, handling properties of the dough, weight of the end product, number of pieces obtained, weight of individual unit, time taken for cooking, yield obtained, spread ratio, expansion ratio, per cent increase in volume for the control recipe and millet based recipe as per the standard procedure.

**Objective and subjective quality characteristics of products:** Products prepared from the women entrepreneurs were procured and evaluated for sensory quality characteristics subjectively and objectively.

**Sensory evaluation of ethnic and novel foods:** Products were evaluated on nine point hedonic scale (1-very poor,

9-excellent) by a panel of ten trained members at Food Laboratory, Department of Food Science and Nutrition, College of Rural Home Science, University of Agricultural Sciences, Dharwad (Srilakshmi, 2007).

**Nutrient composition of ethnic and novel foods:** Selected products were assessed for nutrient composition by computation method using 'Nutritive value of Indian foods', and compared between control and millet recipes (Gopalan *et al.*, 2004).

### Results and Discussion

Technological features of ethnic and novel foods of millets in comparison with standard foods are presented in Table 1 and Table 2. Significant variation was observed for most of the technological features of different millet products, viz., total weight of the end product, number of pieces obtained, spread ratio of biscuits, expansion ratio of *papads*, per cent increase in the volume of baked *paddu*, baking/cooking/frying time, making time/grinding time of the product as compared to the respectable standard products. It is evident from Table 2 that technological features of ethnic and novel foods of millets differed significantly during different stages of processing. Time taken for grinding, baking of *paddu*, preparation of *papad*, roasting of flour, making of *laddu* and frying of *chakali* of millet was significantly lower than the standard recipes. This may be due to the smaller size of millet grains which take lesser time for hydration and cooking (Mallesh and Hadimani, 1993). The expansion ratio of fried *papad* and spread ratio of biscuits were significantly lower than the standard recipes whereas the per cent increase in the volume of *paddu* was significantly higher than standard recipes. These unique technological features of millet products showed the possibility of their use as time and fuel saving grains. These technological features can replace or serve as an alternative to rice or wheat or any pulse flour in conventional or novel food preparations such as fermented foods, fried foods, and convenient foods or in bakery industries.

The evaluation of ethnic and novel foods of millets as compared to standard ones revealed that the sensory scores of all the quality parameters were higher for standard recipes as compared to those made with millets (Table 3). These differences were however non-significant for most of the traits. Furthermore, it is also interesting to note that though sensory scores were low for millet products for most characters, their rating scored 7 and above, which indicated that these products were under the category of "very good" for acceptability. The results

of the study show that millet products have a potential to be widely acceptable and popularized in the national market. The price of the main ingredient is one of the important factors for assessing the cost benefit ratio of the end product. The cost of Bengal gram *dhal* is Rs. 50/kg, which is far higher than that of millets (Rs. 12-14/kg). The cost of pulse based recipe-*laddoo* in the market is around Rs. 160-180/kg. Therefore, replacement of Bengal gram flour with that of millet yielded therefore a cheaper product with on par acceptability for all the sensory quality parameters (Table 3). Similarly, the per cent increase in the volume of the *paddu* is one of the important quality and economic character which adds additional profit to millet products. The number of biscuits that can be prepared with a unit quantity of millet flour is also higher as compared to that produced with the flour of other grains and this gain in productivity is certainly another interesting feature that can be used for enhancing the marketing of millet-based products.

From a nutritional point of view, the ethnic and novel products of millets were found to be comparatively richer in protein and mineral content than those made out of rice or wheat (Table 4). Although, no significant difference was observed for the sensory quality characters and technological features of standard biscuits and millet biscuits, the latter were found to bear greater amounts of proteins and calcium. Such a fact represents a highly strategic element in our attempt to enhance the nutritional

values of bakery products in India and deserve greater attention of policy makers and industrial sector. Indeed, since substitution of less refined millet flour to standard recipes, has improved the nutritional quality of the products by increasing macro as well as micronutrients, recipes based with small millets need to be widely popularized for combating hidden nutritional deficiencies, particularly high among school going children.

Besides their nutritional contribution, small millets also play a strategic role as instrument of empowerment of women. In the framework of the IFAD-NUS project, hundreds of women were trained on preparing value-added products, of great acceptability and demand at the local level. As a result of their acquired skills, the trained women gained greater self-confidence in their food production activities at both household and market level, with positive impact on their own family and communities. Furthermore, complementary training efforts in marketing food products made some of these women, associated with SHGs promoted by the project, also successful entrepreneurs.

## Conclusion

The ethnic millet *papads*, *chakali*, fermented breakfast food '*paddu*', novel foods like biscuits, *laddu* all prepared with small millets proved to have a good scope for enhancing nutrition security, marketing and income generation of community members, particularly rural

**Table 1. Technological features of processed ethnic and novel foods of millets in comparison to standard foods**

Type of food	Main ingredient	Qty. of main ingredient (g)	Total weight of the dough (g)	Total weight of the cooked food (g)	Weight of one piece (g)	Total number of pieces	
<i>Paddu</i>	Rice	Rice	200	–	147.00**	7.00*	21
	Millet	Little millet	200	–	136.50	6.50	21
t-value	–	–	–	–	24.37	1.36	NS
<i>Papad</i>	Rice	Rice	250	753.66*	370.00**	5.00	74.00**
	Millet	Little millet	250	702.33	345.00	5.00	69.00
t-value	–	–	–	2.70	16.27	NS	17.10
Biscuit	<i>Maida</i>	<i>Maida</i>	200	–	461.66**	11.26**	43.00
	Millet	<i>Maida +Ragi</i> flour	100+100	–	422.66	9.93	45.00**
t-value	–	–	–	–	12.78	29.49	35.01
Ladoo	<i>Besan</i>	<i>Besan</i>	250	545.66	545.66	30.46	17.00
	Millet	<i>Besan</i> flour +Foftail millet	125+125	551.0	551.00	30.23	18.00**
t-value	–	–	–	1.67 ns	1.38 ns	0.49 NS	2.47
<i>Chakali</i>	Rice	Rice	250	599.00	510.00	–	–
	Millet	Little millet	250	598.00	538.66**	–	–
t-value	–	–	–	0.5 ns	14.76	–	–

\* Significant \*\* Highly significant NS-Non Significant

**Table 2. Technological features of processed ethnic and novel foods of millet during different stages of processing**

Food	Type of processing	Technological features observed	t-value
Preparation of fermented breakfast food - <i>paddu</i>	Grinding time	Time taken to grind soaked rice was more (18.5** sec) than little millet (4.5 sec).	175.14
	Baking time	Time taken for baking of one set of rice <i>paddu</i> was more (9.19 min**) than little millet (6.30 min)	118.43
	Per cent increase in the volume of the baked product	Per cent increase in the volume of baked product of one set of rice <i>paddu</i> was lower (21.8%) than little millet <i>paddu</i> (25.45%**)	16.55
<i>Papad</i> preparation	Rolling of <i>papad</i>	<i>Papad</i> pressing was very easy with the dough of little millet as compared to rice	–
	Time taken to roll	The time taken for rolling of one rice <i>papad</i> was higher (25 sec**) than the little millet (22 sec)	29.86
	Frying quality	The expansion ratio of fried rice <i>papad</i> was higher (2.23**) than little millet (1.92)	14.96
Biscuit making	Spreading quality	Spreading ratio of standard biscuits was higher (4.00 cm**) than <i>ragi</i> biscuits (3.17)	19.21
<i>Ladoo</i> making	Time taken for roasting	Time taken for roasting of Bengal gram flour to attain golden brown colour was more (40 min**) as compared to foxtail millet flour (35 min)	8.34
	Time taken for <i>ladoo</i> making	Foxtail millet dough was very easy to handle during preparation of <i>ladoo</i> and the time taken was lesser (20min) than standard recipe (30min**)	13.08
<i>Chakli</i> preparation	Pressing of <i>chakli</i>	Pressing of little millet dough was very easy as compared to rice	–
	Frying time	The frying time of one set of rice <i>chakli</i> was more (6.5 min**) compared to millet (5.0min)	1.22

\* Significant \*\* Highly significant

**Table 3. Mean sensory evaluation scores of ethnic and novel foods of millets in comparison to standard recipes**

	Colour and appearance	Texture	Taste	Aroma	Overall acceptability
<b>A. Ethnic foods</b>					
<b><i>Paddu</i></b>					
Standard	8.3**	8.0*	8.2	7.8**	8.0
Millet	7.5	7.6	7.9	7.1	7.8
t-value	3.53	2.44	N.S	3.13	N.S
<b><i>Papad</i></b>					
Standard	7.8**	8.1**	8.1	7.8	8.0
Millet	7.1	7.0	7.4	7.5	7.6
t-value	2.27	3.97	N.S	N.S	N.S
<b>B. Novel foods</b>					
<b><i>Biscuit</i></b>					
Standard	7.6**	6.4	6.5	6.5	7.0
Millet	6.2	6.9	6.5	6.7	7.1
t-value	3.32	N.S	N.S	N.S	N.S
<b><i>Ladoo</i></b>					
Standard	7.5	6.8	7.2	6.9	7.3
Millet	7.6	7.7	7.7	7.3	7.6
t-value	N.S	N.S	N.S	N.S	N.S
<b><i>Chakli</i></b>					
Standard	7.9*	8.0**	8.2**	7.8**	7.9**
Millet	7.2	7.0	7.3	7.1	7.0
t-value	2.27	3.0	2.74	2.27	3.25

\* Significant \*\* Highly significant NS-Non Significant

women. Value addition also showed to be a highly strategic intervention in the popularization of nutritionally and technologically rich local crops which are currently largely neglected and underutilized. As this project has demonstrated, the success and sustainability of efforts in this domain are, however, largely dependent upon an effective synergy among highly complementary disciplines, including crop improvement, nutrition, food technology, marketing, education, public awareness and policies.

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Table 4. Nutritive value of ethnic and novel foods

Parameters	Rice	Millet
<b>Paddu-100g</b>		
Carbohydrates(g)	123.02	111.63
Protein(g)	19.03	20.85
Fat(g)	10.96	12.58
Ash(g)	2.02	4.75
Crude fibre(g)	0.75	12.42
Calcium (mg)	68.86	94.08
Energy(kcal)	666.84	643.18
Calcium (mg)	68.86	94.08
Energy(kcal)	666.84	643.18
<b>Papad-100 g</b>		
CHO( g)	81.82	78.51
Protein(g)	5.79	7.90
Fat(g)	3.06	4.06
Ash(g)	0.52	2.48
Crude fibre(g)	0.66	3.74
Energy(kcal)	377.98	382.18
Calcium (mg)	14.56	34.60
<b>Biscuit-100g</b>		
CHO(g)	57.80	58.69
Protein(g)	4.78	4.35
Fat(g)	26.36	27.88
Ash(g)	0.28	4.55
Crude fibre(g)	0.12	0.92
Energy(Kcal)	487.79	503.07
Calcium (mg)	60.40	90.16
<b>Ladoo-100 g</b>		
CHO(g)	64.46	63.97
Protein(g)	9.58	7.54
Fat(g)	18.91	18.39
Ash(g)	1.27	1.40
Crude Fibre(g)	0.55	2.08
Energy(kcal)	500.00	483.34
Calcium (mg)	28.86	24.81
<b>Chakli-100 g</b>		
CHO(g)	45.48	39.13
Protein(g)	6.92	7.49
Fat(g)	32.33	32.12
Ash(g)	1.16	1.88
Crude fibre(g)	1.04	5.05
Energy(kcal)	501.33	475.58
Calcium (mg)	65.27	72.00

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