Research and Development work conducted at McGill

DEVELOPMENT AND QUALITY EVALUATION OF LITTLE MILLET (*Panicum sumatrense*) INCORPORATED BREAD

By Mamata Mannuramath, UAS-D PhD student

Millets are small seeded grains used for food, feed and forage. Despite their nutritional superiority, utilization of millets is somewhat restricted due to the non-availability of refined and processed millets in ready to eat form. Little millet is a good source of dietary fiber and it possesses a low glycaemic value. In the form of rice, this millet is very popular in Northern parts of India specially consumed during festivals as fasting food. Little millet is nutritionally better compared to wheat and rice. An attempt was made to incorporate millet in the preparation of bread by replacing the traditional wheat flour. Little millet was incorporated in the bread in the millet to wheat ratio of 0:100, 10:90, 30:70 and 50:50. The developed breads were evaluated for their physical characteristics, hardness, colour and sensory quality. The accepted bread was evaluated for nutritional composition and compared to a control wheat bread. As the millet flour per cent increased, the weight, height and whiteness of the bread decreased. Hardness value increased with increase in millet proportion (1.76 to 5.67 N). Sensory evaluation revealed that there was no significant difference between the control and millet incorporated breads (at 10 and 30% millet incorporation). Considering the nutritional benefits of millet, it can be recommended to incorporate millet flour up to 30 per cent without affecting sensory quality of the bread, since the little millet bread with 30 per cent was higher in ash, crude fiber and dietary fiber content compared to the control 100% wheat bread.

PHYSICO-CHEMICAL CHANGES OF BATTER AND *PADDU* PREPARED WITH VARYING PROPORTIONS OF INGREDIENTS WITH LITTLE MILLET OR RICE

By Deepa M. Madalageri, UAS-D M.Sc. student

The present study was undertaken to evaluate the effect of varying proportions of ingredients on the physico-chemical changes of batter and *paddu* of little millet as compared to rice**.** The little millet paddu was prepared by addition of little millet to pulse mix (black gram dhal, Bengal gram dhal, red gram dhal, fenugreek seeds and rice flakes) in the ratio of 2:1, 3:1, 4:1, 5:1 and 6:1 in comparison to rice. The volume of little millet batter increased with increase in the proportion of addition of little millet whereas the volume of batter decreased with an increased proportion of addition of rice. Significant difference in the viscosity of batter was observed between cereals, between fermentation and also between the proportions of ingredients. Significant decrease in the pH of little millet and rice batter was observed after fermentation whereas it did not show significant differences between little millet and rice. Increased proportion of cereals to pulse ratio did not show any significant differences in the physical characteristics of *paddu.* However, texture analysis by instrument revealed that hardness of *paddu* increased with increased proportion of cereals to pulse. Hence 6:1 proportion of little millet and pulse mix was considered as the optimum selection of ingredients for the preparation of little millet paddu.

QUALITY OF LITTLE MILLET (*Panicum sumatrense*) CHAKLI AND EFFECTS OF HYDROCOLLOIDS ON THE PROPERTIES OF LITTLE MILLET CHAKLI

By Hoitinkim Singson, UAS-Dharwad M.Sc. student

Little millet (*Panicum sumatrense*)*chakli* was compared with rice *chakli* and it was observed that little millet *chakli* was nutritionally superior to rice *chakli* and it had a shelf life of two month when packaged in 150 gauge polyethylene cover and stored at ambient temperature. Different hydrocolloids viz. Xanthan, Carboxymethylcellulose (CMC), K4M-Hydroxypropylmethylcellulose (HPMC) and E4M-Hydroxypropylmethylcellulose (HPMC) were added at 0.25, 0.50 and 1.00 % in little millet *chakli* flour mix to see the effect of hydrocolloids in *chakli*. The oil content of the product had decreased with increase addition of hydrocolloids with an increase in moisture content. The hardness of the texture also increased with increase in hydrocolloid percentage and colour turned slightly lighter with hydrocolloid addition. The sensory evaluation revealed that the overall that acceptability of the *chakli* decreased with increase in hydrocolloids percentage. However the score was still acceptable upto 1 per cent addition of hydrocolloids.

DEVELOPMENT AND QUALITY EVALUATION OF FOXTAIL MILLET (*Setaria italica*) INCORPORATED BREAD

By Uma Ballolli, UAS-Dharwad PhD student

The demand for processed foods is ever increasing due to the technological, industrial and economic advances of the developing societies of the world including India. The bakery industry has been steadily growing in the country, being the largest among the processed food industries. With changing lifestyle, urbanisation, increase in per capita income and working spouse these all have made bread a staple food in India.
All purpose flour was replaced by foxtail millet flour at 10, 30 and 50 per cent level for the development of breads. Sensory evaluation scores indicated that refined flour could be replaced up to an extent of 50 per cent with foxtail millet flour. Non significant differences were found between control and up to 50 per cent foxtail millet incorporated breads with respect to colour, flavour, taste, texture and overall acceptability.

AGRICULTURAL SYSTEMS OF KARNATAKA, INDIA: AN AGRICULTURAL DEVELOPMENT APPROACH
An internship outlook report from Ms. Margot Roux (McGill student)

In the agriculture sector, one the major problem is that most of the farmers are restricted to subsistence farming. Indeed, the majority of holdings are marginal or small, for family consumption with very little income generated from it. What is important is that the farmers find an adequate balance between cash crops and staple crops. They need to feed their family

but also to earn money. Millet is an example of staple crop, naturally resistant to droughts, with a constant productivity, which is however too low to be profitable as a cash crop. Instead, farmers can benefits from the help of the government to produce rice and wheat, benefiting from access to inputs and technologies that can be used for the rest of the farm. A main aspect is diversification. This way, farmers reduce risk of dramatic losses, for example due to disease or droughts. It would be a possibility to produce more horticultural crops for example. Another aspect is that it has been proven in many other countries that cooperatives work better for farm development than individual work. If one day rural Indian start grouping for machinery, money or services, they would certainly have easier access to them.
Organic farming has appeared over the last decade in India. Some farms naturally produce organic products but most of them have to be modified to fit the conditions of the label. Organic farming means less inputs from outside the farm, less wastes on the farm, re-use of waste to replace inputs. It is a sustainable farming practice and the farmer can benefit from it.
On the social side of Karnataka, it is important to remember that more than half of the rural population is below the poverty level. This implies that these people are often undernourished, more susceptible to sickness, less efficient at work, their living conditions worsen and over time, they further impoverish themselves. Even though Karnataka is ranked seventh in the national ranking of Human Development Index, the situation of a large part of its population remains alarming. Also, the government has started to act in order to decrease social distinctions. Casts are anchored in the culture so it will take a long time to fade and is likely to persist for a long period of time, where people from the lowest cast have very low chances to have decent lifestyles. Also, gender inequity has always been present in India and as years go by, the population starts fighting against it. The Self-Help Groups are an important example of growing chances for women empowerment in India. Furthermore, women's activities improve their household's living conditions.
The project of implementation of millet shows some interesting approaches. This IDRC project covers the whole production of millet, from the seed variety selection to improvements in culture practices, up to the end, processing and cooking into millet products. The team intervenes at all steps. It is evidently not perfect, as farmers have things to complain about, but that is how the project evolves and improvements can be brought. Millet has the advantage of being a naturally resistant staple crop, and once the farmers get all the tools that facilitate the production, this will ensure their food security.

NUTRITIONAL AND FUNCTIONAL PROPERTIES OF POPPED LITTLE MILLET (*Panicum sumatrense*)

by Priyanka Kapoor, McGill M.Sc. student

Food industries are focusing energies towards the development of functional foods and food ingredients. Several ancient grains are being used as a source of functional nutrients. Millets are minor cereals which have high nutritional value, are non-glutinous and are easily digestible. In spite of this, their consumption is limited. This could be attributed to their non-availability in ready-to-eat and ready-to-use foods. Processing of millets to incorporate them in ready-to-eat foods can increase their nutritional value, availability and economic value. Thermal processing can improve the bioavailability of certain vitamins and minerals and also helps in lowering the water activity thus, preventing the growth of microorganisms. Thermally processed foods also have better organoleptic properties. One interesting method of thermal processing is popping. Popping enhances the carbohydrate and protein digestibility by inactivating some of the enzymes and enzyme inhibitors. Popping also improves the color, appearance, aroma and taste of the processed food commodity. In the present study, the popping quality of little millet (*Panicum sumatrense*) and the effects of popping on the nutrient composition and the functional properties of the millet were studied. The popping quality of little millet was optimized with respect to the temperature of the particulate medium and the moisture content of the millet, both of which were found to determine the yield of popping. The total protein, crude fat and total ash content of the popped millet was almost equal to that of the native millet. Popping increased the non-resistant starch content of little millet. The availability of total phenolics increased from 225 mg GAE/100g sample (db) in native millet to 661.462 mg GAE/100g sample (db) in popped millet. Popped millet flour (PMF) had a higher oil absorption capacity at room temperature as well as at 140°C and also exhibited higher swelling power and solubility. While the cold paste viscosity of the native millet flour (NMF) was 5.359 X 10-3 Pa s, that of PMF varied from 1.5 to 7.5 Pa s. NMF had a hot paste viscosity (HPV) of 0.1908 Pa s whereas the HPV of PMF varied from 1.9 to 7.5 Pa s. From the results obtained in the present study, it was deduced that PMF would form pastes of uniform viscosity which would be more stable to heat during cooking and would have a greater shelf-life. The optimized conditions for popping little millet were obtained at 16% grain moisture and particulate medium temperature of 260°C. It was also confirmed that popped millet flour had advantage over native millet flour with improved nutrient availability and better functional properties.

OPTIMIZATION OF MICROWAVE ASSISTED EXTRACTION OF HIGH VALUE LIPIDS FROM GRAIN AMARANTH

By Siddhartha P Joshi, McGill M.Sc. student

This study optimized the methodology for extracting high value lipid from grain amaranth, which is a rich source of squalene, phytosterols, tocopherol & polyphenols and has an application in nutraceutical & cosmetic based industries. The method used microwave energy to enhance the extraction diffusion processes and to release oil from the grain amaranth at reduced extraction time and reduced solvent consumption as compared with conventional extraction methodologies. Statistical designs were used to identify the process factors – sample to solvent ratio, solvent mixture ratio and extraction time at constant microwave power, that governed the oil yield & preserved the best quality of its high value constituents.

USE OF MILLETS FOR PARTIAL WHEAT REPLACEMENT IN BAKERY PRODUCTS

By Ramesh Murugesan, McGill PhD student

Global food security challenges will persist as a universal concern for the next 50 years and beyond. Achieving food security is an essential target in the global context. To attain food security, it is imperative to shift focus on the crops, which yields nutritious products with minimal investment and water requirement. Millets and sorghum are the oldest of cereals used since ancient times which use much less water and agronomic attention during the cultivation period when compared to wheat and rice. The origins of millets are not precisely known, but millets have been consumed as a food since prehistoric times and millets definitely require a reclassification of their current place in consumption preference. Millets are known for their good taste, very short growing season and ability to grow in very poor soils. With minimal investment and shortage in custom-made post-harvest technologies, millets have shrunk their contribution in the current scenario.

Millets are not only easy to grow and cultivate, they require very less attention during the storage period when compared to other cereal grains. Due to the increase in world population and decrease in water resources for agricultural purposes, millets are important crops for human consumption in near future. Millets provide wide range of health benefits and they are good source of energy, protein, minerals, vitamins, phytochemicals and micronutrients.

Nowadays, bakery products account for a major part of the processed food market and this industry is rapidly changing with advancements in nutraceuticals and new product developments. Wheat is the most important cereal in bakery industry and the demand for wheat is growing year by year as the processing of wheat into variety of products propagates. The main objective behind replacing wheat flour with millets in bakery products is to add more functional and nutritional value to the bakery products. Millet replacements will affect the baking quality and in-turn the overall consumer acceptance. Identifying the right proportion of such replacement products in the baking industry has always been a major challenge.

As a major outcome of this doctoral research, the potential use of millets in general, minor millets in particular, will be promoted in the food industry especially in baking industry. The results of the study would remove the hurdles using millets in the bakery industry by providing an easy to use predictive tool to determine appropriate millet quantity and quality for bakery products. Increase in consumption of millets in the bakery industry will stimulate and encourage farmers to cultivate millets. This would lead to increased production of millets globally. This will have significant impact in resource utilization for agricultural production, as millets are generally highly drought resistant and require minimal care for production, handling and storage. The outcome of this research would also improve the socio-economic status of millet farmers in African and Asian developing countries, as the total market value and demand for millets will increase due to increased demand and consumption.

DEVELOPMENT OF A SYMBIOTIC (PRO AND PREBIOTIC) FINGER MILLET-BASED INFANT WEANING FOOD

By Sara Najdi Hejazi, McGill PhD student

In the present study, controlled food processing approaches like dehulling, soaking, germinating, boiling, roasting, milling, and fermentation can reduce the non-nutritive components of the finger millet and consequently improve the bioavailability of proteins, starch, and minerals while improving the functional and organoleptic properties. The processing of this minor grain would enable its usage as a suitable ingredient in infant weaning food. Besides, it is proposed that food safety, shelf-life, and digestibility of the finger millet would be enhanced through the germination and fermentation procedures. The nutritional characteristics of the product could be improved and optimized through the introduction of supplementary components from grain amaranth and pulses such as lentils and green pea. Since finger millet and the employed supplements are gluten free, the developed product could be served for the infants suffering from celiac disease. Furthermore the fiber components within the finger millet can be consumed as an appropriate prebiotic source for potential added probiotics, such as lactic acid bacteria (LAB). Presence of these probiotics at the final ready-to-eat stage improves the balance of infant's intestinal flora and prevents the incidence of diarrhea and constipation during the introduction of weaning foods in an infant's diet.

Millet dehuller

By S. Sotocinal, V. Orsat, K. Swan, N. Matlashewski, R. Chin and G.S.V. Raghavan, McGill University

Renewed efforts are being made to encourage the cultivation of the minor millets in South East Asia in an attempt to empower rural communities through increased food security and reduced malnutrition. In order to encourage the cultivation of millets, efficient post-harvest processing machines are quintessential.

Minor millets are minor grains with a near spherical shape, an average axial length of 1-1.5 mm and encased by an indigestible single layer hull. The removal of this hull along with the separation of the hull from the edible grains is essential before consumption. The goal of this project was to design an efficient machine that can accomplish effectively the dehulling while remaining affordable and easily operable for the layman in rural communities in India.

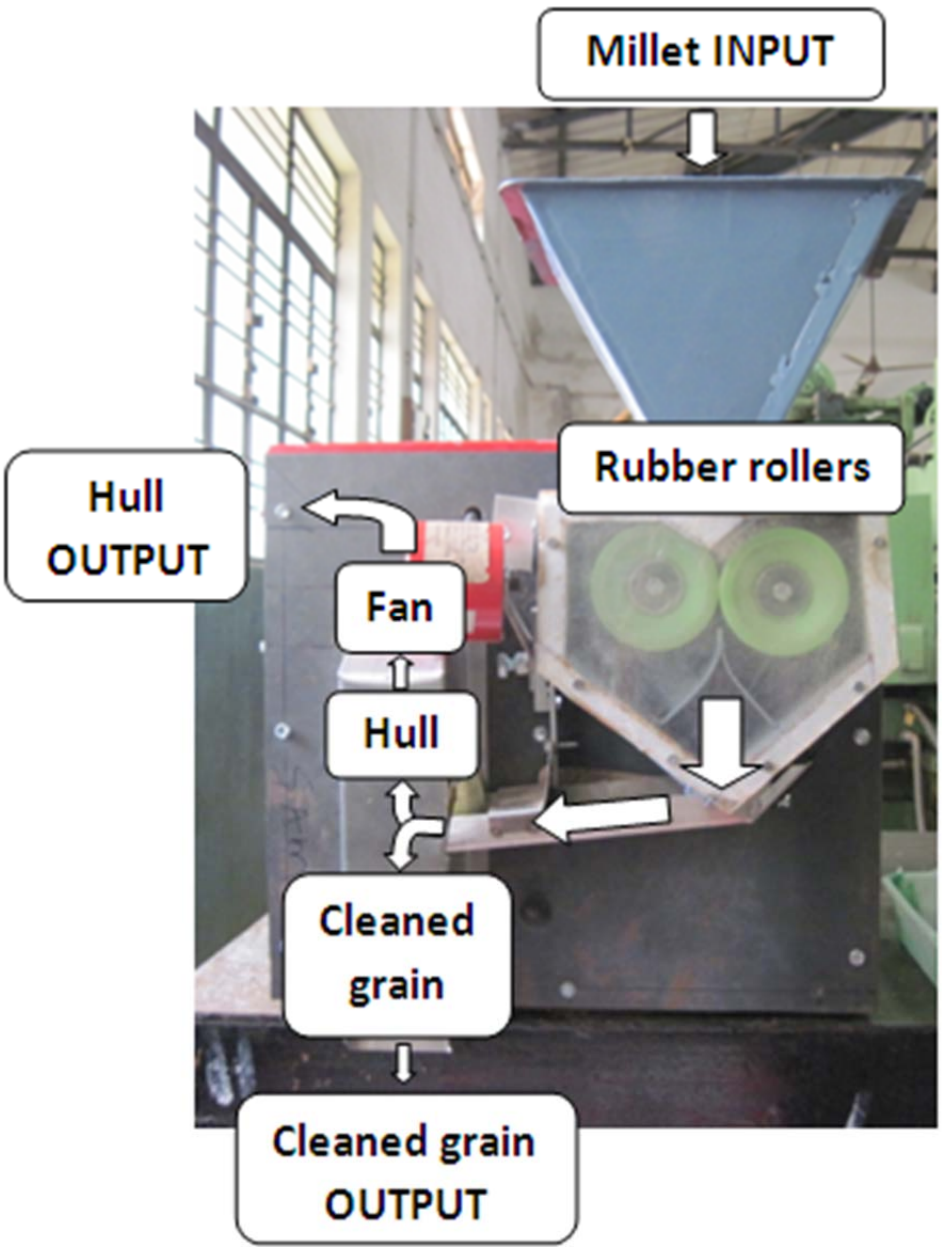
Existing mills include the traditional stone mill and the emery mill both of which can result in a significant amount of broken grains which is undesirable. These existing mills also entail a lot of drudgery for the women who further clean the de-hulled grain from the hulls. In response to these concerns, a centrifugal mill was designed and prototyped in Dharwad, India in 2011. The mill was then re-configured in Montreal, Canada in 2011-2012 to use rubber rollers which resulted in fewer broken grains as compared to the centrifugal mill. The original centrifugal portion was therefore used as a fan as a means to separate the cleaned grain from the hulls which decreases women's drudgery associated with cleaning the grains.

The efficiency of the rubber roller mill is 99% and is advantageous as compared to the currently used emery mill since the former doesn't cause as many broken grains as the latter. The rubber roller mill has been shown to decrease women's drudgery by eliminating the time required for winnowing since it separates the de-hulled grain from the hulls.

The rubber roller mill has a capacity of about 6kg/h which is adequate for village use at the household level. The rubber roller mill with 0.5HP motor is more appropriate and accessible for household level use than the emery mill since the former uses single-phase electrical power, while the latter uses 3-phase electrical power which is not standard at the household level and also costs more per kWh of electricity, making the cost of operation cheaper for the rubber roller mill.

Since the rubber roller mill uses shearing force rather than abrasive force like in the emery mill, the bran remains on the grain which provides increased nutrition as compared to the millet that has gone through the emery mill. While the de-hulled millet is not acceptable as rice, there is a wide variety of products that can be made with the millets. Using the rubber roller mill to de-hull millet can help in improving the livelihoods and food security of rural families through value-added products and improved nutrition.

Rubber roller mill



Village testing and comparing the rubber roller mill with the emery mill

Testing was carried out in Timmapur village (Karnataka) whereby the existing emery mill for millets was compared against the rubber roller mill. The current practices for the emery mill consist of 3-passes and hand-pounding before consumption; therefore two 2kg of millet sample were passed through the emery mill 3 times each, with one of the samples undergoing hand-pounding. In order to compare the times and efficiencies for varying numbers of passes, two 1kg samples were passed through the emery mill; one went through 1-pass while the second went through 2-passes. The millet samples that had been de-hulled through the rubber roller mill underwent two types of tests with the intention of providing some polishing to the grain: hand-pounding and polishing through the emery mill. Two hand-pounding tests were carried out for samples of 1kg: with and without conditioning whereby conditioning is the application of water which is supposed to make it easier for the husk to be removed. Polishing through the emery mill was tested for 1-pass and 2-pass using 1kg samples.

Results

Kari Savi and CO(SA)4 samples were fed through the rubber roller mill at various feed rates and number of passes. The lowest and highest capacities were 1.7kg/h and 4.1kg/h, respectively, for Kari Savi and 2.3kg/h and 3.6kg/h, respectively, for CO(SA)4.

The greatest de-hulling efficiency of Savi was 98.9%. There was a slight decrease in efficiency for 3-pass as compared to 2-pass due to the increased shearing between the rubber rollers which causes more broken grains.

The greatest de-hulling efficiency for CO(SA)4 was 99.3%.

The fastest time for de-hulling, polishing and winnowing was seen for the sample that went through the emery mill for 1-pass which took 15 minutes and 56 seconds for 1kg. The slowest time was for the sample that went through the rubber roller mill through 2-pass and was hand-pounded but not conditioned; it took 47 minutes and 33 seconds. The de-hulling, polishing and winnowing through the use of the emery mill is 1.7 times faster than with the rubber roller mill. Even though the sample that went through the rubber roller mill through 2-passes and was hand-pounded without conditioning took the longest amount of time, it had the highest de-hulling efficiency: 98.9%, compared to <90% for the emery mill.

The cooked millet rice from the emery sample was white in colour while the rubber roller sample was tan-coloured which is indicative of bran still being present in the latter sample. The villagers preferred the emery sample since the rubber roller sample left an aftertaste of bran in their mouths.

In order to try to decrease the bran content of the millet, samples from the rubber roller mill were passed through the laboratory scale rice polisher. The rice polisher works due to abrasion and therefore causes a significant amount of broken grains. The time taken for polishing is about 4 minutes and 26 seconds for 1kg for the 0.5HP motor which translates to 0.083Rs/kg. However, there were many broken grains. Upon further discussion, it was decided that the de-hulled grain can be transformed directly into flour to make other products, therefore polishing was not deemed an important step.

Discussion

In addition to the experimental results, practical considerations were taken into account when determining the parameters to follow for efficient de-hulling. The number of passes was influenced by the time required for de-hulling. Although there were improved efficiencies for some of the experiments when the sample had undergone 3-passes as compared to 2-passes, the additional time required would be an impracticality for users when comparing the efficiencies. Therefore, testing was carried out for 2-passes for the most part.

The expected use of the end product from the rubber roller mill was also shifted from the original utilization as rice to instead being transformed into flour in order to make a variety of different products. This enables the bran to remain on the millet which provides increased nutritional value to the value-added products. One of the millet dishes that closely resembles rice is upma and it has been accepted by the villagers. Other products that have been made include chakli, roti, dosa, idli and paddu and have been accepted as well.

Another type of test that will be conducted is a storage study test of the de-hulled samples. It is hypothesized that since the bran will remain on the grain, that the storage length and keeping quality of the grain will be improved as compared to polished grains which can oxidize more easily. Therefore, if this hypothesis is true, then the bran-coated millet will be more resilient to storage and also provide more nutrition to consumers.

Approximation of the cost of the rubber roller mill

The professors from SDM College of Engineering and Technology estimated that the cost of the rubber roller mill is Rs. 15,000. This includes one of the major costs of the 0.5HP motor which costs Rs. 4,000. In order to make the adoption of the rubber roller mill more attractive and affordable for villagers, subsidy programs should be introduced in order to help defray the investment costs.

TECHNICAL VISITS and INDUSTRIAL TOURS in CANADA

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Dr. Rakesh Kumar and Dr. Kiran Negi, December 2011

Dr. Anil Joshi, October 2012

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