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REVIEW ARTICLE

Millet based multigrain mix: its physico-chemical properties and value addition- a review

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ABSTRACT

Millets are now-a days considered as superfoods as they contain numerous health protective factors including dietary fibre, phytochemicals and antioxidant properties. The goodness of millets can be combined with other commonly consumed flours such as whole wheat flour to make it nutritionally superior. The concept of multigrain mixes is gaining attention as one grain can supplement the nutrients that are lacking in the other grains. These multigrain mixes can be utilized in development of diversified food products like bakery and puffed products, quick cooking cereals, ready-to-eat snacks, supplementary foods, weaning foods, and more importantly health foods. The present study is aiming on review of work done on the formulation, physico-chemical evaluation of millet based multigrain mixes and value-added products prepared using millet based multigrain mixes.

Keywords: Millets, multigrain, antioxidants, dietary fibre, micronutrients

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INTRODUCTION

Millets are one of the oldest foods recognized to humans and perhaps the first cereal grain to be used for domestic purposes (Vudugula, 2018). Millet is widely used to refer to a variety of grains that are very popular for their culinary uses as well as their health promoting qualities (Chandrasekara et al., 2012). People in Africa and India use it in many of their recipes (Amadou et al., 2014). Although millet is one of the world's most significant food crops, it is cultivated typically in the Eastern hemisphere and predominantly in regions with primitive agricultural practices and high population densities. Millets are chief food sources for millions of people, especially those who live in hot, dry areas of the world (Adekunle, 2012). Millets are mostly grown in marginal areas and under agricultural conditions in which major cereals fail to harvest substantial yield (FAO, 2008). India is the highest producer of millets producing 10.30 million tonnes with 36% of the world total production (FAO, 2017).

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They are nutri-cereals which are highly nutritious and are identified to contain high nutrient content which includes protein, essential fatty acids, dietary fibre, B-vitamins, minerals such as calcium, iron, zinc, potassium and magnesium. They help in rendering health benefits like reduction in blood sugar level (diabetes), blood pressure regulation, thyroid, cardiovascular and celiac diseases (Rao et al., 2017).

FORMULATION OF MILLET BASED MULTIGRAIN MIX

Multigrain mixes are prepared by combining two or more grains together and processed to develop a product with special health benefits. Its basic principle lies in the fact that each grain has its own nutritional profile, thus combining two or more grains may impart additional nutrients. Hence, a multigrain product provides bundle of nutrients, which may not be sufficiently available through single grain consumption (Arya et al., 2013). The concept of multi-grain flour/composite flour is not new to the mankind, as it offers many beneficial components including vitamins, minerals, phytochemicals, antioxidants and essential amino acids which impart protective effects against non-communicable diseases. Addition of functional ingredients in the multigrain flour increases its nutritional and biological value (Slavin, 2003).

Various studies have reported about development of multi-purpose multigrain mixes for the preparation of value added products. Proso millet based multigrain mix with soybean and groundnut was developed by Srivastava et al. (2001). The mix was used for the development of different foods such as sweet gruel, salty gruel, halwa, burfi and biscuits. Machewad et al. (2006) developed an instant mix with a combination of sorghum flour and soy bean flour, sorghum flour and puffed chick pea flour and they reported that 25 per cent of inclusion of both the pulse flour were highly acceptable and a significant increase in the protein content of the flour was observed. Composite flour mix was developed by Deshpande and Poshadri (2011) using foxtail millet (60%), amaranthus seeds (5%), rice (5%), Bengal gram (20%) and cowpea (10%) which was reported to produce quality extrudates with acceptable sensory properties. Anju and Sarita (2010) developed two types of multipurpose composite flour mix using foxtail millet flour (45%) with refined wheat flour (55%) and barnyard millet flour (45%) with refined wheat flour (55%) and were acceptable A nutritious ready mix was prepared from finger millet, quality maize protein, Bengal gram and soybean in the proportion of 40:25:25:10. It was organoleptically highly acceptable and had higher protein content (Rekhasinha et al., 2012). The composite flour comprising kodo and barnyard millet flour blend at 1:1 ratio, whole wheat flour and defatted soy flour of four different combinations at a level of 0%, 10%, 20% and 30% of millet flour blend, 90%, 80%, 70% and 60% incorporation of wheat flour and keeping the level of defatted soy flour at 10% in all combinations and was found acceptable even at 30% level of incorporation of millet blend (Vijaykumar and Mohankumar, 2009).

PHYSICO-CHEMICAL CHARACTERISTICS OF MILLET BASED MULTIGRAIN MIXES

Physical and functional properties of millet based multigrain mixes

Physical and functional characteristics *viz*., bulk density, water absorption capacity, oil absorption capacity and viscosity of multigrain mixes play an important role in determining the acceptability of the product. Vijaykumar and Mohankumar (2009) developed multigrain mix using kodo and barnyard millet flours in the ratio of 1:1. The mixture was blended at 0, 10, 20 and 30 percent level with whole wheat flour (90, 80, 70 and 60%) and defatted soy flour (10%). Further, developed mixtures were analysed for physical characteristics and results revealed that bulk density, true density, porosity, swelling power, hot paste viscosity and cold paste viscosity decreased with the increase in millet incorporation (0.60 – 0.54 g/ml, 2.5 – 1.19 g/ml, 76 – 54.5%, 3.165 – 2.715 ml/g, 1942 –1053 cp and 2972 – 2578 cp, respectively).

A multigrain mix with rice, wheat, finger millet, Bengal gram, green gram, soy flour, nuts and oil seeds were prepared by Banu et al. (2012) and reported the water absorption capacity, water solubility index, swelling power, solubility and bulk density as 2.3g/g, 4.80 %, 9.90 %, 18.90 % and 0.60 g/ml, respectively. It was concluded that the multigrain mix can be used for the preparation of food formulations such as savory products, snacks, pancake, snacks like *muruku* etc.

Pradeep et al. (2014) developed multigrain ready to eat snack mix using sorghum, pearl millet, grain amaranthus, Bengal gram, green gram and soybean and found that the bulk density, water absorption capacity and water solubility index of the multigrain mix were 0.66 g/ml, 178.00 g/100g and 7.80 g/100g respectively. Bulk density of the product was 0.66 g/ml which indicated its fluffy nature. Dispersibility of a flour is the ease with which the food powder becomes distributed as a particulate in the liquid phase. Higher values indicate better dispersibility (Shittu and Olaitan, 2011).

Kurahatti (2010) formulated little millet based multigrain mix along with green gram, Bengal gram and groundnuts where the swelling power, solubility and dispersibility of the formulations were in the range of 4.56 – 5.44 g/g, 13.00 – 20.40 % and 71.85 – 79.25% respectively, which revealed that it is suitable for use in making value added food formulations.

Singh and Singh (2003) studied the physical and functional characteristics of whole and milled flour of foxtail, barnyard and finger millet flours. Blends of 0, 10, 20 and 30per cent levels millet flours and wheat flour and Bengal gram flour were prepared. Significant reductions in water absorption, fat absorption, emulsification and foaming indices were observed for finger millet flours blends. It was concluded that when 10 to 30 per cent whole and milled flours were blended with wheat flour and Bengal gram flour, the functional characteristics differed significantly in case of whole millet flours.

Nutrient composition of millet based multigrain mix

Multigrain mixes were developed using two varieties of sorghum (CSH-1, M35-1), green gram and sesame flour at different proportions (Kulkarni et al., 1991) and analyzed for nutritional quality. As the proportion of green gram increased, there was an increase in protein, fat, calcium and iron with a significant decrease in carbohydrates and energy in mixes of both the varieties. The mixes contained 14.31 to 17.46g of protein, 2.35 – 2.63g ash, 1.70 – 2.34 g crude fibre, 75.5 – 80.83g carbohydrates, 361 - 385 Kcal energy, 18.29 – 26.2 mg ascorbic acid and 11.37 – 12.01 mg of iron.

Two mixes were formulated using rice or finger millet, lima bean and peanut at the ratio of 65:25:15 and analyzed the nutrient composition (Geetha and Suja, 1996). The authors reported that the nutrient content finger millet based mix per 100g of was increased in terms of protein (12.08g), fat (6.8g), ash (1.10g), iron (2.5mg), phosphorus (283mg) and calcium (260mg) content compared to rice based mix (12.20g, 5.9g, 0.9g, 0.5mg, 205mg and 63mg/100g, respectively).

Nnam (2000) formulated eight multi-mixes using maize, sorghum, cowpea, soybean, yam, coco yam, plantain and sweet potato at the ratio of 65:30:05 (cereal: legume: starchy staple). Results of nutrient analysis revealed that, soybean in combination with sorghum or maize contained higher amounts of protein (20.03 to 23.00 %), fat (7.67 – 7.74%), crude fibre (2.46 – 3.71%) and calcium (70.06 – 81.69 mg).

Banu et al. (2012) reported that multigrain composite mixes containing cereals, legumes, millets and nuts had 10 - 12 g/100g moisture, 56 - 61 g/100g carbohydrate, 15 - 20 g/100g protein, 9 - 13g/100g crude lipid and 2 - 3 g/100g ash. Energy value

ranged from 1600 - 1700 kJ/100g. Among the vitamins studied, thiamine and riboflavin content varied from 0.23 - 0.45 mg/100g and from 8.70 to 21.60 microgram/100g respectively. Dietary fibre was in the range of 12.40 –16.50 g/100g.

Srivastava et al. (2001) developed proso millet based malted and popped convenience mixes along with soybean and peanut flours, in the ratio of 70:15:15. Popped mix contained significantly higher amounts of fat (5.43 g/100g), protein (15.98 g/100g) and energy (336 Kcal/100g) compared to malted mix (5.00 g, 14.35 g, and 328 Kcal/100 g, respectively).

Eight composite mixes were formulated using 40% cereals (wheat, finger millet, pearl millet or sorghum), legumes (20 or 10% defatted soy flour or 10 % Bengal gram), jaggery (30 %) and vegetable fat (5%). The mixes, fortified with vitamins and minerals were analyzed for proximate composition and dietary fibre (Baskaran et al., 2000). Results indicated that mixes contained 10.40 to 12.50 g/100g protein, 4.20 to 5.90 g/100g fat, 10.00 to 13.00 g/100g dietary fibre, 1.80 to 3.60 g/100g ash, 64 to 67g/100g carbohydrates and 340 to 398 Kcal/100g of energy.

Ijirotimi et al. (2006) developed multigrain mixes using sorghum and pigeon peas at different proportions i.e. 90:10, 80:20, 70:30, 60:40 and 50:50 respectively and analysed nutritional profile. With the increase in proportion of pigeon pea, an increase was recorded in crude protein and crude fibre content with a simultaneous decrease in carbohydrate content. The developed mixes contained 12.70 -21.90 g protein, 2.30 -2.60 g fat, 1.40 -2.20 g crude fibre, 5.80 -6.50 g ash and 58.30 -71.80 g carbohydrates.

Four composite mixes were developed by Patil (2009) using wheat, ragi, bajara, soy bean, flaxseed, cluster bean, drumstick leaves and *amruthballi* stem powder in the ratio of 50:15:15:12:2.0 :3.75:2.0:0.25, respectively. Composite mixes were subjected to chemical analysis namely macronutrient micronutrients and antinutrients. The results revealed the moisture (5.76-6.86%), protein (15.34-17.96%), fat (4.33-6.33%), crude fibre (2.84-3.44 %), carbohydrate (64.39-66.29%) and energy (373.23-384.19 Kcal/100g) contents respectively. Calcium, phosphorous, iron and zinc ranged from 211.33- 355.08mg/100g, 275.10-368.16mg/100g, 7.30 -7.96mg/100g, 2.46-3.52mg/100g, respectively.

Bioactive components and total antioxidant capacity of millet based multigrain mix

The foods we commonly consume contain phenolics, flavonoids, tocopherols and carotenoids, which serve as a good source of natural antioxidants and are reported to have health beneficial effects. Phenolic compounds are one of the most highly diversified group of phytochemicals found in all plant origin foods and are therefore an integral part of the human diet (Miller et al*.,* 2000). Banu et al. (2012) reported that multigrain composite mixes with cereals, legumes, millets, nuts had phenolic content ranged from 1.20 to 1.50%, DPPH free radical scavenging activity ranged from 75.20–86.20% and metal chelating activity ranged from 1.90 to 3.90%.

Bhatt and Gupta (2015) formulated composite flours using sorghum, buckwheat, Bengal gram, wheat and barley and reported the total phenolic content and total flavonoid content in the range of 11.80 – 17.87 µg GAE/g and 21.60 – 104.20 µg QE/g, respectively. Pradeep et al. (2014) studied development of multigrain mix including sorghum, pearl millet, grain amaranthus, Bengal gram, green gram and soybean and reported the polyphenol content of the mix as 0.80 g/100g. Gull (2015) developed finger millet based multigrain mix and reported the total phenolic content as 0.67 mg GAE/g. The antioxidant activity of the mix was expressed in terms of DPPH radical scavenging activity which was found to be 38.45 per cent.

Storage study of millet based multigrain mix

Storage of multigrain mixes results in changes in sensory and chemical parameters i.e. moisture content, free fatty acid, peroxide value, alcoholic acidity, microbial growth when packed in several packaging materials and stored at different environmental conditions (Kurahatti, 2010). The studies related to shelf life of composite mix are reviewed here.

Formulation developed using malted finger millet, horse gram and roasted peanut at the proportion of 65:25:10 (Chandrasekhar et al., 1988) was evaluated for storage stability. Mix was stored in household containers like plastic containers, tins, glass bottles and polythene bags for a period of 45 days and results revealed that as storage period progressed, moisture content increased. But the per cent increase was higher in tin containers (6.25 - 9.02%) and lower in polythene bags (6.25 - 7.39%) compared to plastic containers (6.25 - 8.86%) and glass bottles (6.25 - 9.00%). The stored formulation was also tested for bacterial count. In the beginning of the study, plate count was 10,150 per gram of mix but at the end of storage, it increased to 38,550 per gram in polythene bag which was the lowest as compared to other packages. However, mixes stored in all the packages were within the ISI specifications (50,000 colonies per gram of mix) till the 45th day with respect to bacterial count.

Four supplements developed using cereals (wheat and pearl millet), pulses (Bengal gram and green gram), amaranth leaves and jaggery at the proportion of 4:1:1:1 (Dahiya and Kapoor, 1994), were stored in three packaging materials *viz*., polythene bags, tin containers and glass bottles for a period of 30 days. As the storage period increased there was a significant increase in moisture, peroxide value, fat acidity and alcoholic acidity. Mixes stored in tin containers possessed higher moisture (6.85 – 8.16%), peroxide value (3.65 – 5.30 meq/kg fat), fat acidity (24.43 – 25.95%) and alcoholic acidity (0.08 – 0.12%).

Geetha and Suja (1996) evaluated shelf life of rice or finger millet, lima bean and peanut based mixes (at the ratio of cereal: lima bean: peanut in 65:25:15), packed the mixes in polythene pouches, glass bottles and plastic containers and stored fora period of 45 days. Results revealed that moisture content showed slight increase between zero to fifteen days of storage. The maximum level of increase in moisture was noticed for the samples stored in plastic container (6.10 to 8.30% in rice based mix and 5.30 to 7.45 % in finger millet based mix) compared to polythene pouches and glass bottles.

Premavalli et al. (2003) reported that finger millet based convenience mixes *viz*., sweetened and spiced mix was formulated and their storage stability studied. Three combinations of each mix were prepared, sealed in polypropylene pouches, stored at room temperature and at 37°C and evaluated for chemical and sensory qualities. The hydrolytic changes for free fatty acids increased with the temperature and period of storage. The sweetened and spiced mixes had a shelf-life of 6 and 4 months with 7.7 and 6 acceptability score, respectively. Statistical analysis of sensory data revealed that in sweetened mix, relative taste variation was more associated with over all acceptability, while in spiced mix both taste and aroma were associated and the variation was significant at 1% level.

The composite mixes containing 80 per cent foxtail millet or little millet, 10 per cent black gram dhal and 8 per cent hypoglycemic spices for diabetics was developed and evaluated for their shelf life. The mixes were stored in three different packages such as aluminum container, polyethylene bag and aluminum pouch. The results revealed that significant increases in moisture and peroxide values in the mix stored in aluminum container as compared storage in sealed packages. The mixes stored well up to 165 days in sealed packages. Therefore, the sealed package offered better suitability for storage of millet based mixes from economic, convenience and sensory point of view (Itagi et al., 2003).

VALUE ADDED PRODUCTS FROM MILLET BASED MULTIGRAIN MIX

Cookie/biscuits

Biscuits were developed by incorporating 40 per cent finger millet or barnyard millet to wheat flour for diabetics by Srivastava et al. (2002). Sensory evaluation revealed that the millet biscuits were as acceptable as the control (wheat biscuits). Finger millet biscuit and barnyard millet biscuit had a glycemic index of 48.71 and 50.17 respectively compared to 73.58 for control biscuits indicating that these biscuits were suitable for diabetics.

Deepak (1991) reported that acceptable cookies could be prepared by incorporation of finger millet flour into wheat flour to a level of 50 per cent. Olatunji et al. (1992) reported that 45 per cent sorghum or millet flour with 5 per cent full fat soy flour could be substituted to produce excellent-quality biscuits. Verma et al. (2003) developed biscuits from sorghum flour, wheat flour, soyflour and groundnut. The results revealed that the biscuits were a good source of energy and protein. Sensory evaluation scores ranged between 6 and 7 on a 9 point hedonic scale.

Tiku et al. (2003) produced high quality nutritional biscuits using local raw materials such as wheat, finger millet, jowar, corn, soy, groundnut and sesame. The products had 17.00 to 19.60 g protein, 18.00 to 20.00 g fat with 450 to 500 kcal of energy per 100g. The lysine content of the product was 0.40 to 0.70 g compared to 0.01 to 0.05 g/100g material in the commercial wheat biscuits. Methionine content was 3 times higher and calcium content was 1.5 times higher than commercial biscuits.

Cookies were developed using finger millet flour, puffed finger millet flour, starch, soy flour, mango powder, pudina and coriander in different combinations, providing modified starch, improvement in protein, calcium and vitamins. The cookies were highly attractive and flavoured with sensory score of 7.80 to 8.30 on a 9-pointhedonic scale (Swamy et al., 2003).

Soy incorporated millet based biscuits were developed by addition of kodo millet and kutki flour at 70, 80, 90 and 100% level for increasing protein content of biscuit and utilization of millet. When millet flour was fortified with soy flour it gave high level of protein of 11.88 per cent of biscuit for 70 per cent kodo flour incorporation, which was higher than that of 5.09 per cent for control biscuits. Fat content increased from11.98 per cent for control biscuits to 14.82 per cent for 100 per cent kodo based soy incorporated biscuits (Kumar et al., 2010). Ballolli (2010) developed nutraceuticals enriched barnyard millet cookies by incorporating nuts and dry fruits such as cashew grits and dates flakes, five percent each in the standard barnyard millet cookie recipe. The barnyard millet cookies were found very acceptable with light and crisp texture, pleasant aroma and excellent taste.

Bread

Acceptable bread loaves could be prepared by substitution of wheat flour with sorghum flour to the extent of 15 to20 per cent, in case of 75 per cent to 85 per cent extraction rate of refined sorghum flour, respectively (Rao and Rao, 1997).

Singh et al. (2012) optimized millet-based composite flours for the preparation of breads. Barnyard millet and wheat composite flour were formulated and prepared by mixing 61.80 g/100 g barnyard millet, 31.40 g/100 g wheat, and 6.80 g/100 g gluten. The results of sensory analysis show that the acceptability of bread samples prepared from composite flours was almost equal to that of the wheat bread.

A sensory evaluation on bread was made from 50 per cent sorghum based composite flour (Carson et al., 2000). The descriptive test was used to identify the characteristics of aroma, crumb flavour, top crust flavour and texture of the bread by composition with a commercial rye bread. The acceptance test indicated that up to 50 per cent sorghum composite bread was well received by most of the panelists. Ismail et al. (2000) revealed that sorghum cultivars PVK-801 was superior in sensory qualities of bread whereas PVK-829 had the best texture and taste values.

Noodles and pasta

Noodles of different combinations were prepared such as noodles exclusively made of finger millet, finger millet and wheat in the ratio of 1:1 and finger millet blended with wheat and soy flour in the ratio of 5:4:1 which were found acceptable (Devaraju et al., 2006). Shukla and Srivastava (2011) developed noodle for diabetic patients by using finger millet (30%) and refined wheat flour (50%). Based on the sensory evaluation, 30% finger millet incorporated noodles were selected and evaluated for glycemic response as compared to a control. The results showed that glycemic index of 30% finger-millet-incorporated noodles were significantly lower than control noodles.

Sowbhagya and Ali (2001) developed laboratory processes for making noodles from millets *viz*., sorghum, finger millet, pearl millet, foxtail millet and little millet. The millet based noodles were reported to be quick in cooking and good in appearance. Udupa et al. (2002) reported that finger millet noodles were comparable to wheat noodles in terms of dough characteristics, extrusion and reconstitution capacity and could be prepared using blends having 60-70 finger millet flour, 20 per cent refined wheat flour and 10-20 per cent defatted soy flour. Finger millet noodles also had a higher content of protein, calcium and iron.

Shanthi et al. (2005) studied the effect of incorporation of finger millet in pasta products. Refined wheat flour, whole wheat flour and soy flour was blended in different proportions with finger millet and sensory evaluation revealed that incorporation of finger millet up to 30 per cent and soy flour up to 10 per cent was acceptable.

Finger millet based ready to eat extruded snacks was developed by Suneeta et al. (2003). The product was formulated using finger millet (50 per cent), refined wheat flour (25 per cent), defatted soya flour (15 per cent) and skimmed milk powder (10 per cent). The sensory attributes of the product were found acceptable with score of 4, judged on 5 point hedonic scale.

Devaraju et al. (2003) standardized the preparation of pasta products using composite finger millet flour (50 per cent) refined wheat flour (40 per cent), defatted soy/whey protein concentrate (10 per cent). The finger millet based pasta products, had good cooking quality, storage stability, acceptability and higher nutritive value on comparison with the standard.

Traditional food items

Sharavathy et al. (2001) stated that *chapati, dosa, idli, pongal, poori*, *roti*, flakes, upma and semolina *idli* are important cereal based Indian traditional foods in which different cereal and millets can be used. The optimum formulations of mixes i.e. millet *pakoda* mix, millet *jamun* mix, millet *dosa* mix, millet *roti* mix with 8.00 to 8.40 sensory score of the product were achieved with 30-70 per cent incorporation of finger millet flour (Kumar et al., 2002).

Manohar and Rao (2002) developed *chapatis* with good sensory quality and aroma by incorporation of 30 per cent raw sorghum flour, blended with 20 per cent steamed sorghum flour to 50 per cent wheat flour. Selvi et al. (2002) revealed that

pearl millet flour is traditionally consumed as *roti* along with jaggery. It is also used as thick and thin porridge, steam cooked and boiled.

Vijayakumar and Mohankumar (2009) carried out a study to expand the utility of Kodo and barnyard millets by incorporating them in whole wheat flour and defatted soy flour mixture and studied the impact of millet flour blend on different quality characteristics of *chapati*. The incorporation of millet flour blend and soy flour improved the quality of *chapati* in terms of nutrient density and taste. The 30 percent millet flour blend incorporated composite flour based *chapati* was highly acceptable.

Roopa et al. (2003) developed enriched flour mix from wheat, malted ragi, soya bean and drumstick leaf powder in the ratio of 50:25:15:10 for *chapathi* preparation. Geetu et al. (2003) developed acceptable *laddoos* incorporated with popped pearl millet at 100 and 50 percent levels in a basic recipe containing roasted chickpea and groundnut (both at 25% levels). The nutrient composition of the *laddoo* with 100 percent millet was reported to be superior to 50 per cent millet *laddoos*. *Laddoos* prepared from 100 percent popped pearl millet had low polyphenol and phytic acid and was high in *in vitro* protein and starch digestibility as compared to those *laddoos* prepared from a blend of millet, groundnut and chickpea. The stored *laddoos* were organoleptically acceptable up to three months.

Barnyard millets and finger millet were incorporated in *khichadi, laddoo* and *baati* along with legumes and fenugreek seeds (Arora and Srivastava, 2002). *Khichadi* mix was prepared with millet, whole green gram and fenugreek seeds in the ratio of 60:20:20. *Laddoo* mix contained millet, roasted soybean, malted fenugreek seeds in the proportion of 65:10:20, along with 5 per cent popped amaranth seeds. Millet based *baati* was prepared with fenugreek seed powder and roasted Bengal gram flour both at 20 per cent.

Scientific experiments have been carried out to enhance the nutritional quality of common convenience foods such as *papads,* by substituting conventional grains with nutritious millet. *Papads* was formulated using finger millet (60%), Sago (20%), black gram (20%) along with spices (Begum et al., 2003). Calcium was reported to be exceptionally higher in *papads* with finger millet (156 mg /100g) compared with traditional *papads* (82 mg/100g).

Suitability of barnyard millet in cereal-based common traditional foods was studied by Veena et al. (2003). Five traditional foods rice, *idli, dosa, roti* and *chakli*, were prepared by different methods of cooking, *viz*., boiling, pan baking, fermentation, shallow and deep fat frying. The main ingredient of the selected food (except of cooked rice) was substituted with barnyard millet flour in varying levels of 0, 25, 50, 75 and 100 percent. Incorporation of the millet altered the nutrient composition of the foods without affecting organoleptic characters. Substitution of barnyard millet in rice- based foods increased the nutrients per serving in terms of dietary fiber and minerals but reduced calorific value proportionately to the level of substitution.

Sharma and Sayeeda (2005) standardized *idli* prepared from kodo millet. Proportion of standard *idli* was parboiled rice (60g), black gram (30), fenugreek seeds (5g) and water. Proportion of millet *idli* were parboiled rice (30g), black gram (30g), kodo millet (30g), sprouted fenugreek seeds (5g) and water. Proportions of kodo *idli* were kodo millet (60g), black gram (30g), sprouted fenugreek seeds (5g) and water. Nutritive value of kodo *idli* was significantly high when compared to control and millet *idli* with parboiled rice.

Varnashree et al. (2008) evaluated the *idlis* prepared by using finger millet and finger millet flour along with other ingredients such as parboiled rice and black gram dhal flour in different ratio. Presoaked whole finger millet *idlis* resulted in soft texture

and the *idlis* prepared with finger millet flour had dark colour compared to whole finger millet *idlis*. Incorporation of whole finger millet in the preparation of *idlis* did not affect the acceptability of the product. The study concluded that finger millet could be used to replace rice in the preparation of *idli* enhancing the nutritional quality without considerable effect on the quality parameters of *idli*.

An attempt was made to develop chemically leavened millet legume based instant *idli* mix by Kamareddi et al. (2003) with various proportions of little millet, rice and black gram with different chemical leavening agents. The proportions of little millet, semolina and black gram flour was 4:1:1 along with sodium bicarbonate (0.2%), citric acid (0.05%) and salt (2.00%) was found to be optimum in terms of cost, bulk density and acceptability of the steamed product. *Idli*, prepared with one part of instant mix soaked in 0.5 parts of curds and 1.5 parts water at room temperature for 30 min followed by steaming for 10 min gave a product of high consumer acceptability.

Kulkarni et al. (2011) developed value added millet based traditional food products and tested their acceptability. The products developed were proso millet sweet pongal, little millet *paddu* and *dosa* with *chakramuni* leaves, little millet *idli* with *methi* leaves and carrot, little millet *upma* with drumstick leaves and with Bengal gram leaves, barnyard millet based *upma* with drumstick leaves, foxtails millet *vada* with greens and foxtail millet based *besibelebhath*. The value added millet based traditional products were highly nutritious, cost effective and sustainable strategy to alleviate the hidden hunger and for the management of life style disorders.

Kumari and Srivastava (2000) standardized and evaluated sweet *burfi* from malted finger millet flour and reported that the product from malted finger millet resulted in significant changes in nutrient composition and the sensory evaluation of *burfi* indicated that the product was highly acceptable.

CONCLUSION

Multigrain mixes offer many beneficial components including vitamins, minerals, phytochemicals, antioxidants and essential amino acids which impart protective effects against non-communicable diseases. Addition of functional ingredients in the multigrain flour increases its nutritional and biological value. Addition of pulses and legumes such as Bengal gram, green gram, pea, soybean etc. enhances the protein content of the product. Cereals in the composite mixes can be substituted with millets in the formulation to get the advantage of enhanced micronutrients and dietary fibre. Cereal based foodstuffs supplemented with millets have become progressively popular due to nutritional and economic advantages. Value added products from millets have the potential to add worth to business and has a large potential for development as consumers believe that millets and millet-based foods contribute good nutrition, directly to their health. The millet grains offer many opportunities for the development of diversified food products like bakery and puffed products, quick cooking cereals, ready-to-eat snacks, supplementary foods, weaning foods, and more importantly health foods by adopting appropriate milling and processing techniques.

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