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Suitability of Quality Protein Maize (QPM) for the Preparation of Multipurpose Mix

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Abstract

The term 'Multipurpose mix' means simple and convenient food that can be consumed in diversified ways by developing a variety of products. Multipurpose mix (MPM) is comprised of mixture of malted quality protein maize (QPM) flour, malted green gram flour, malted ragi flour, grain amaranthus, dehydrated carrot powder and skimmed milk powder in varying proportions. The MPM was standardized using 50, 60 and 70 per cent QPM flour incorporation along with other ingredients. The shelf life of MPM stored in PET pouches for a period of six months was test for sensory, biochemical and microbial quality every month. The sensory quality of MPM indicated that among the three variations tested, the 50 per cent QPM incorporated products *viz.,* burfi, laddu, health drink and roti were found to be acceptable compared to rest of the combinations tested. The developed multipurpose mix had protein 12.94 g, calcium 250 mg, iron 6.75 mg, magnesium 10.46 mg and phosphorus 355 mg per 100g. The increase in moisture (5.5 to 9.56 %) peroxide value (1.2 to 2.65 m eq /kg of fat) and free fatty acids (0.32 to 0.96 %) were in the acceptable range during storage. There were no fungal and mould colonies throughout the storage period. The consumer acceptability (N=90) including rural and urban (82.2 %) people rated the products prepared out of MPM as 'very good'.

Keywords: Multipurpose mix, Quality protein maize, Malting, Peroxide value

Maize (*Zea mays* L.) is the third most important cereal in India, after Rice and Wheat. Currently, 1037 million MT of maize is being produced by over 170 countries from an area of 185 million ha with an average productivity of 5.62 t/ha. In India, maize is being produced in an area of 9.6 million ha with a production and productivity of 25.90 million MT and 2,689 kg/ ha respectively (Anon., 2017). Maize is a good source of carbohydrates, fats, protein and some of the important vitamins and minerals. Several million people especially in the developing countries derive their protein and calorie requirements from maize. However, in spite of several important uses, maize has an inbuilt drawback of being deficient in two essential amino acids, *viz.,* lysine and tryptophan. This is responsible for poor net protein utilization and low biological value of traditional maize genotypes: Maize breeders resolved this through developing quality protein maize (QPM) by incorporating opaque-2 mutant gene which is particularly responsible for enhancing deficient amino acids of maize genotype. In the recent past, quality protein maize (QPM) has got special distinction among the cereals due to presence of high amount of essential amino acids *viz.,* lysine (4.92 %) and tryptophan (1.20 %). Further quality protein maize can be utilized for diversified purposes to attain food and nutritional security as infant food, health food, convenience food, specialty food and emergency rations (Jat *et al.,* 2009).

The term 'Instant food mix' refers to that mix where in some of the ingredients are premixed. It is simple, convenient, easy and fast to prepare. Convenience foods provide the housewives novelty, convenience, drudgery reduction and satisfaction of preparing at home (Roopa, 2015). Convenience foods (CF) or Ready-to-cook foods are those which are processed or prepared to be ready-to-cook with very little additional effort (Sharma *et al*., 2009). Ready to eat (RTE), quick cooking and instant foods have become very common largely due to today's life style and the demand for such quick-to-serve foods (Dhumal *et al.,* 2014). Multigrain product is basically prepared by mixing two or more grains together; its basic principle

lies in the fact that each grain has its own nutritional profile, hence combining two or more grains may give additional nutrients. Thus multigrain product provides bundle of nutrients, which may not be sufficiently available through single grain consumption. Therefore, in the present study an attempt was made to develop maize based multipurpose mix using quality protein maize flour, along with other nutritious ingredients incorporation. From the previous review it is evident that multipurpose mixes (MPM) using QPM flour has not been reported and is open for research. However other mixes such as convenient mixes, instant mixes, ready-to-cook (RTC) mixes, ready-to-eat (RTE) mixes etc, are available in plenty. Hence, the present study was conducted to develop multipurpose mix using quality protein maize (QPM) and evaluate its quality.

Material and Methods

The maize grains of quality protein hybrid (Shakthimam-4) were procured from AICRP Dholi (Bihar) centre and other ingredients like green gram, ragi, grain amarathus and skimmed milk powder were purchased from local market in a single lot and refrigerated until further use.

Development of multipurpose mix (MPM)

(a) Lime treatment of (QPM) grain: QPM grains were cleaned and soaked in 1 per cent lime water $Ca(OH)_2$ at simmering temperature for 30 min. After the application of heat treatment, the vessel was taken off the heat and allowed to cool over night followed by washing three to four times with fresh water to remove lime. Consequently it was subjected to sun drying to reduce (moisture level to 9-10 %). The sundried samples were stored in air tight containers (Fig. 1).

(b) Malting and preparation of MPM: QPM grain, whole green gram dhal and finger millet (ragi) grains were cleaned and soaked for eight hours, subsequently water was strained, tied in muslin cloth and kept for germination process in air tight box (ragi and whole green gram were subjected to germination for about 24 hours, while QPM grains for about 48 hours (Fig. 2). The germinated grains were dried separately

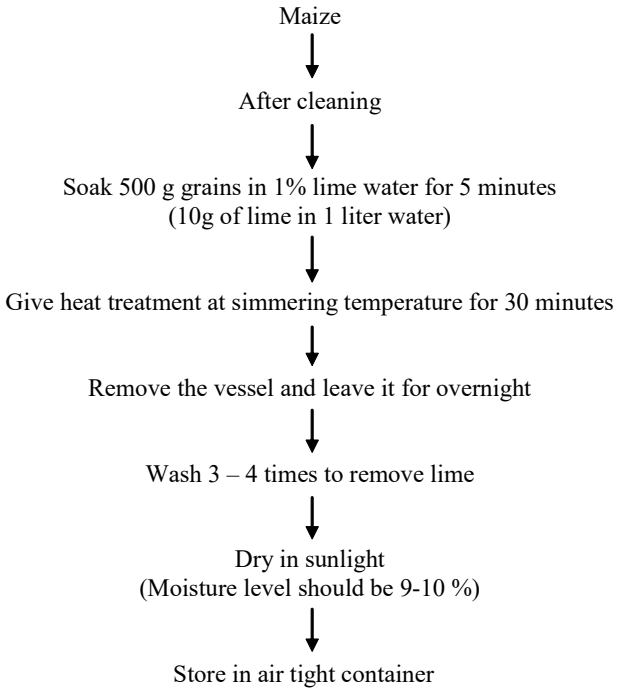

Fig. 1: Lime treatment of (QPM) grains

Fig. 2: Malting and preparation of multipurpose mix (MPM)

under shade for 8-12 hours followed by drying process and the germinated portion was removed by winnowing and hand abrasion. The germinated grains were roasted separately under low temperature (90 ± 2 ^{0}C) until mild aroma flavor arises. The grains were cooled at room temperature. Cooled grains were powdered separately and sieved using 60 mesh sieve. Grain amarathus powder, skimmed milk powder and dehydrated carrot powder were added and mixed uniformly by sieving followed by packing in polyethylene teraphthalate (PET) jars and stored at room temperature (27 ± 5 ^{0}C). The different products such as burfi, health drink, laddu and roti were prepared using three levels of MPM incorporation (50, 60 and 70 %) following conventional method of preparations.

Sensory evaluation

Sensory evaluation was carried out by a panel of 21 semi trained judges using 5-point hedonic scale (Ranganna, 1986) to select the best acceptable level of QPM flour incorporation. Scores were allotted for appearance, taste, flavor, texture and overall acceptability.

Analysis of nutritional composition

Developed multipurpose mix (MPM) was analyzed for moisture, protein and fat contents (AOAC, 2005). Carbohydrate content was estimated by difference (Livesey, 1995). For mineral estimation the samples were prepared by dissolving the ash obtained after ashing the samples in a muffle furnace in dilute hydrochloric acid (1:1 v/v). Calcium and phosphorus contents were estimated according to standard procedure of AOAC (1995), iron by Wong's method (Wong, 1928) while magnesium and potassium were estimated by the methods of versanate titration and Ranganna (1986), respectively.

Storage study

The prepared multipurpose mix (MPM) was packed in PET covers and samples were drawn periodically every month for analysis of moisture, peroxide value and free fatty acids AACC (2000) until six months. Microbial load including bacteria, fungi and moulds were assessed every month during storage period (Collins and Lyne, 1970).

Consumer acceptance

In order to know the general acceptance of products prepared out of MPM, the health drink was served to rural and urban people of Mandya city and asked to rate the product under three category as 'good' 'very good' and 'not good'.

Statistical analysis

Analysis of the data was carried out in triplicates. The data was analyzed statistically for the mean, standard deviation and ANOVA was used to test the significance among different levels of (QPM) incorporation and effect of storage on shelf life of the products at 5 per cent significance level.

Results and Discussion

Nutritional composition of the multipurpose mix (MPM)

The perusal of Table 1 indicates that the multipurpose mix prepared using 50 per cent QPM flour incorporation was found to contain fairly good amount of protein (12.94 %) which was due to addition of green gram and skim milk powder. Similar line of work reported that the protein content of wheat, sorghum and oat bars was found to contain 12.66 per cent, 9.35 per cent and 11.24 per cent protein, respectively. The MPM had calcium content of 250 mg per 100 g which was due to addition of malted green gram, grain amarathus and ragi. The work conducted by Beatriz (2012) also supports that the calcium, iron and zinc contents of grain amaranth were found to be higher compared to wheat and barley. Hence, in the present study, addition of grain amaranthus might have contributed to higher calcium and iron contents (Table 1). However, variation in mineral composition observed in different crops and products was due to location of crop, season of year, plant population and selection of variety and fertilizer application (Singh and Raghuvanshi, 2012). Obviously the phosphorus (355 mg/100g) and potassium content (210 mg/100g) of the mix was fairly good, because maize is a good source of phosphorous which contains 348 mg of phosphorus and 291 mg of potassium per 100 g as quoted by Gopalan *et al*. (2000).

TABLE 1
Nutritional composition of multipurpose mix (MPM) per 100 g

Nutrients	Quantity
Energy (kcal)	352.28 ± 1.143
Carbohydrates (g)	66.13 ± 0.925
Moisture (g)	9.56 ± 0.020
Ash (g)	2.62 ± 0.0208
Fat (g)	4.75 ± 0.05
Protein (g)	12.94 ± 0.023
Crude fibre (g)	4.00 ± 0.01
Calcium (mg)	250.00 ± 3.21
Magnesium (mg)	10.46 ± 0.052
Phosphorus (mg)	355.00 ± 1.0
Potassium (mg)	210.00 ± 2.0
Iron (mg)	6.75 ± 0.05

Note: Values are mean of three replications ± SD

Sensory Evaluation of Multipurpose mix (MPM)

The perusal of Table 2 depicts the sensory evaluation of MPM products such as burfi, health drink, laddu and roti on a five point hedonic scale, which indicated that 50 per cent maize malt incorporated burfi scored good (4.0) in overall acceptability, colour (4.1) and texture (4.2). Significant differences were observed between three variations tested. Among three variations, 50 per cent MPM incorporated burfi was acceptable compared to rest of the variations tested (60 and 70 %). Similar study conducted by Ananthan *et al.* (2013) indicated that the sensory attributes of flax oat nutty bar exhibited significant differences with respect to colour, aroma, taste, texture and overall acceptability of bars with variation in ingredient levels. Even the study of Luciana *et al.* (2012) reported that the mean sensory acceptability value of the soy snack bars prepared with different levels of soya incorporation indicated that 70 per cent soya incorporated snack bar received highest sensory scores compared to rest of the ratios. In the present study, the sensory evaluation for maize laddu (Table 2) prepared from 50 per cent QPM flour incorporated MPM scored good to very good (3.8) for overall acceptability, where as taste (4.0) and flavor (4.3) of the same scored between from very good to excellent. Even the sensory evaluation for maize roti (Table 2) revealed that roti prepared out of 50 per cent MPM incorporated multipurpose mix scored between good to very good (3.5) in taste and overall acceptability.

Storage studies of the multipurpose mix (MPM)

Storage of any product determines its wholesomeness during the definite period of time (Shobha *et al.,* 2011). The biochemical changes during storage includes changes in onset of rancidity in terms of moisture, peroxide value, free fatty acid and microbial quality. The perusal of Fig. 3 revealed that, there was significant ($P<0.05$) increase in moisture content during storage of MPM from initial to six months (5.5 to 9.56 %). Similar line of work carried out reported that the moisture content of the malted ragi and green gram based weaning food packed in different packaging materials increased but did not attain the critical level *i.e.,* 11 per cent until 150 days of storage. The moisture level of MPM is also well within this safe limits. The peroxide value expressed as milli equivalents of oxygen per kg of fat indicates that the generation of hydrogen peroxides due to oxidation of fat catalyzed by reactive oxygen and these components are not stable. Hence they are converted into simple volatile flavor components that could be recognized as the oxidized flavors (Manoj Kumar, 2014). The present study (Fig. 4) indicated significant increase in peroxide value (1.2 to 2.65 meq/kg of fat) from initial to end of storage

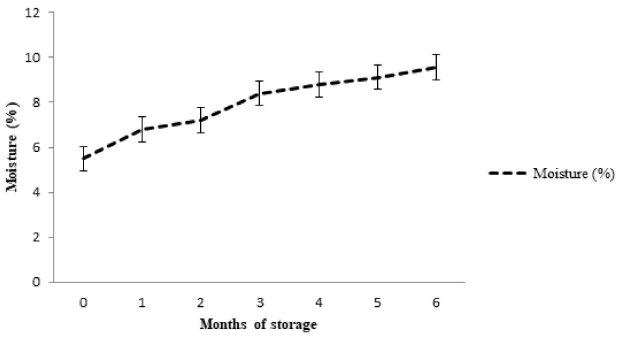

Fig. 3: Changes in moisture content during storage of multipurpose mix (MPM)

TABLE 2

Sensory evaluation of products prepared with multipurpose mix (MPM)

Products prepared from MPM	Sensory parameters	Ingredient variations			Statistical analysis		
		50 per cent	60 per cent	70 per cent	F-Value	SEm±	CD at 5 per cent
MPM Burfi	Appearance	4.40	2.70	2.30	50.86	0.22	0.45
	Colour	4.50	2.80	2.70	27.09	0.27	0.56
	Texture	3.80	3.20	2.70	7.25	0.29	0.59
	Flavour	4.20	2.90	3.20	12.39	0.27	0.56
	Taste	4.20	3.30	2.80	12.03	0.29	0.59
	OAA	3.80	2.70	2.50	12.97	0.27	0.56
MPMHealth Drink	Appearance	4.40	2.70	2.30	50.86	0.22	0.45
	Colour	4.50	2.80	2.70	27.09	0.27	0.56
	Texture	3.80	3.20	2.70	7.25	0.29	0.59
	Flavour	4.20	2.90	3.20	12.39	0.27	0.56
	Taste	4.20	3.30	2.80	12.03	0.29	0.59
	OAA	3.80	2.70	2.50	12.97	0.27	0.56
MPM Laddus	Appearance	4.2	4.0	4.2	0.47	NS	NS
	Colour	3.7	3.6	3.9	0.20	NS	NS
	Texture	4.3	4.0	3.8	1.33	NS	NS
	Flavour	3.9	4.3	3.2	2.06	NS	NS
	Taste	3.9	4.0	3.5	0.17	NS	NS
	OAA	3.9	3.8	3.7	0.09	NS	NS
MPM Roti	Appearance	2.6	3.4	3.5	8.47	0.27	0.58
	Colour	3.3	3.6	3.4	1.80	NS	NS
	Texture	2.7	3.1	3.5	2.06	NS	NS
	Flavour	3.2	3.7	3.3	3.95	NS	NS
	Taste	2.8	3.5	3.1	7.23	0.26	0.55
	OAA	2.7	3.6	3.0	16.20	0.22	0.47

Note: 50 per cent maize malt, 60 per cent maize malt, 70 per cent maize malt; NS: Non significant; OAA- Overall acceptability
Score pattern: 1: poor, 2 : fair, 3: good, 4 : very good, 5: excellent

period. Similar changes were observed in the nutrimix packed in laminated pouches and PET jars in the earlier study. The changes in free fatty acid contents (Fig. 5) in MPM was about 0.32 per cent during first month which increased to 0.96 per cent at the end of storage period. Work conducted by Saha and Dunkwal (2009) indicated that increase of free fatty acid value from 0.3 to 2.2 mg for spread instant mix over a period of 90 days. Values reported in this study were within the limits for noticeable rancidity, wherein for an oil

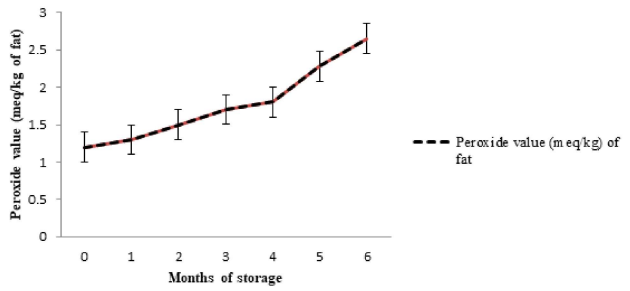

Fig. 4: Changes in peroxide value during storage of multipurpose mix (MPM)

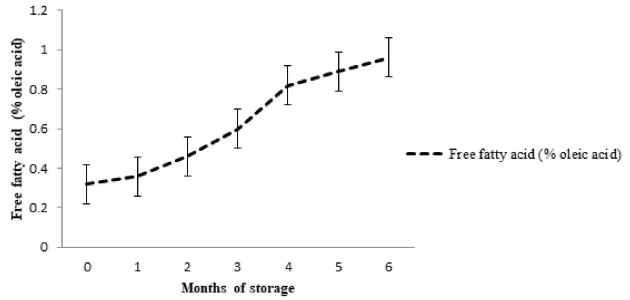

Fig. 5: Changes in free fatty acid contents during storage of multipurpose mix (MPM)

product, the FFA level should not exceed 1.5 per cent and peroxide value 20-40 meq / kg fat. It is evident from the Table 3, that the microbial quality of the mix was excellent as there were no fungal and mould colonies throughout the storage period. Very few bacterial colonies were found after four months of storage which might have been added from water, ingredients, processing and handling methods and were found to be gram negative. Consumer acceptability (Table 7) of health drink prepared out of multipurpose mix had scores of good to very good (82.2 %) by rural and urban consumers. Similar study conducted by Sudharani *et al.* (2013) on ash gourd and amla based instant soup and juice mixes showed that juice mix was highly accepted and appreciated by 68 per cent of UG and 56 per cent of PG students.

Thus the study indicated that, the multipurpose mix (MPM) prepared using 50 per cent of QPM flour with other ingredients such as malted green gram flour, ragi flour, grain amaranthus and skimmed milk powder had scores between good to very good *w.r.t.* sensory quality. The nutritional composition of the MPM was found to be good in terms of protein, calcium and iron.

TABLE 3

Microbial load of multipurpose mix (MPM)

Period of microbial analysis	Fungi Cfu/ml of sample	Bacteria Cfu/ml of sample	Moulds Cfu/ml of sample
	10^{-5}	10^{-3}	10^{-5}
Initial (0)	0.0	0.0	0,0
1 Month	0.0	0.0	0.0
2 Month	0.0	0.0	0.0
3 Month	0.0	0.0	0.0
4 Month	0.0	1.16 ± 0.15	0.0
5 Month	0.0	1.26 ± 0.37	0.0
6 Month	0.0	2.1 ± 0.15	0.0

Note: Values are mean of three replications ± SD

TABLE 4

Consumer acceptability studies of health drink **(N=90)** prepared out of MPM

Consumer ratings	V. C .Farm		A. G. College		Mandya		Total	
	No.	%	No.	%	No.	%	No.	%
Very good	22	73.3	28	93.3	24	80	74	82.2
Good	4	13.3	2	6.6	4	13.3	10	11.1
Not good	4	13.3	0	0	2	6.6	6	6.6
Total	30	100	30	100	30	100	90	100

It can be stored up to six months in PET covers without significant changes in physical, chemical and microbial quality. The MPM can be used in diversified product preparations such as burfi, health drink, roti and laddu. The MPM can be suitably consumed in simple and convenient manner by the consumers of all age group. Consumers of urban and rural segments rated the product prepared out of MPM as "very good".

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