Journal of Crop and Weed, 15(1): 45-49 (2019)

Hybrid maize (QPM) for nutritional security

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Received : 05-10-2018 ; Revised : 15-02-2019 ; Accepted : 05-03-2019

ABSTRACT

Cereals are the most important source of world's food and have significant impact in human diet. Maize (Zea mays) is a major cereal crop for human nutrition worldwide with its high content of carbohydrates, fats, proteins, some of the important vitamins and minerals. Maize acquired a well deserved reputation as a poor man's nutra- cereal. However, in spite of several important uses, maize has an inbuilt drawback of being deficient in two essential amino acids, viz., lysine and tryptophan. To overcome this, the breeding scientist mutated the normal maize and made grain proteins in the endosperm nearly twice as nutritious as those found in normal maize which is called as Quality Protein Maize (QPM). Effective utilization of QPM in diversified way, by conversion into a variety of products for use as infant foods, health foods/ mixes, convenience foods specialty foods and emergency ration we can achieve the food and nutritional security of our country. Hence, the present study was undertaken to develop nutritious recipes based on QPM maize as flour and suji (semolina) by supplementing with pulses. Quality protein maize (QPM) was substituted with different proportions in traditional foods (Idli, Dosa, Pittu and Adai), convenience foods (Papad and Noodles), bakery foods (Cookies and Bread) and snack foods (Vada and pakoda) which were organoleptically evaluated using 9 point hedonic scale and also estimated the nutrient composition of the products. The entire products were scored maximum acceptability and their nutrients content were higher compared to native maize based products. This contributes food and nutritional security by meeting energy and protein needs of consumer.

Keywords**:** Commercialization, hybrid maize, product development and QPM

Cereals are the most important source of world's food and have significant impact in human diet. In India and Africa, cereal products comprise of 80 per cent or more of the average diet, 50 per cent in central and Western Europe and between 20-25 per cent in the US (Adebayo *et al.*, 2010). Maize (*Zea mays*) is a major cereal crop for human nutrition worldwide with its high content of carbohydrates, fats, proteins, some of the important vitamins and minerals. Maize acquired a well deserved reputation as a poor man's nutra- cereal. Globally, maize is known as a queen of cereals because it has the highest genetic yield potential among the cereals. Maize ranks third after wheat and rice as one of the world's three leading food grains, are grown on 140 million hectare in 100 countries and produced 700 million metric tons of grain in 2004. The top six producers of maize in the world are United States, China, Brazil, Mexico, France, and India and they share the 75 per cent of total world maize production Maize, providing an estimated 15 per cent of the world's protein and 20 per cent of the world's calories, is a dietary staple for more than 200 million people. This number can be expected to grow as the world's population approaches 8 billion in 2025 (Nuss and Tanumihardjo, 2010). However, in spite of several important uses, maize has an inbuilt drawback of being deficient in two essential amino acids, *viz.,* lysine and tryptophan and the same has been overcome through an inter- disciplinary research involving breeders, biochemists and other disciplinary scientists. Thus, discovery of maize mutants in the mid-1960s containing the *opaque-2* gene which enhances levels of lysine and tryptophan in the endosperm protein, opened a new era in breeding for improvement of quality in maize. International Maize and Wheat Improvement Center (CIMMYT) identified the most productive maize cultivars with high lysine and tryptophan contents. Through back crossing and several recurrent selections, maize breeders of CIMMYT and the National Research Institute for Forestry, Agriculture and Livestock (INIFAP) have successfully developed 26 hybrids and cultivars, similar in yield and other important agronomic properties to normal maize. These new high-quality protein genotypes are collectively called quality protein maize (QPM) (Milan-Carrillo *et al.*, 2004).

Quality Protein Maize hybrids incorporate an "*opaque-2*" gene identified from mutants within maize which reduces the concentration of prolamine, the dominant protein fraction in the regular maize kernels that are high in leucine and isoleucine. Today more than 23 countries have released and are producing QPM in the developing world. Three decades of research at CIMMYT has led to the development of QPM cultivars that possess high- yield and better quality that can lead to nutritional security among developing world poor. In order to achieve the food and nutritional security of our country the current thrust is an effective utilization of QPM and its products in diversified way, by conversion into a variety of products for use as infant foods, health

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foods/ mixes, convenience foods specialty foods and emergency ration (Shobha *et al.*, 2011). Hence, the present study was undertaken to develop nutritious recipes based on QPM maize as flour and suji (semolina) by supplementing with pulses.

MATERIALS AND METHODS

The present research was carried out in the Food Science and Nutrition department laboratory, Home Science College and Research Institute. Madurai. The normal maize variety CO1 bought from Department of millets, Tamil Nadu Agricultural University Coimbatore, Quality protein maize (QPM) variety HQPM 7 was bought from Zonal Agricultural Research Station (ZARS), Mandyal, Karnataka, India and other ingredients used for the study were bought from the local market.

Processing of value added products from maize

The CO 1 and HQPM 7 maize varieties were pulverized into flour and grits form in a commercial mill and the flour was sieved using BS 60 mesh sieve. Flour and grits were used for processing into different ready to use and ready to eat value added products at different incorporation levels of substitution.

Maize flour and refined wheat flour blends were used to develop noodles, cookies and bread. While maize flour and rice flour blends were used to develop pittu mix and vadagam. Papad was developed using maize flour and black gram flour blends. Traditional south Indian foods like dosa and idli were developed from maize, rice and black gram and pakoda from maize flour, bengal gram flour and rice flour blends. The sensory attributes of the products were evaluated using a nine point hedonic scale as given by Srilakshmi (2006) to determine the level of acceptability of the maize flour incorporated products.

RESULTS AND DISCUSSION

The products were developed using CO 1 and HQPM 7 maize varieties at different levels of substitution and sensory attributes of the products were evaluated using a nine point hedonic scale. The organoleptic scores of maize flour incorporated traditional and ready to use convenience foods are presented in the table- 1 and 2.

Traditional foods

Papad prepared from 30 per cent maize flour substitution recorded the maximum acceptability in CO1 and HQPM 7 maize varieties and had the overall acceptability scores of 8.8±0.84 and 8.5±0.57 respectively. Vadagam, dehydrated product was prepared from whole maize flour of both the varieties obtained the overall acceptability scores of 8.4±0.31 and 8.6±0.56, respectively. Traditional foods namely, kesari, upuma and puliyotharai were prepared from 100 per cent CO1 as well as HQPM 7 maize grits and had the overall acceptability scores of 8.0±0.25, 8.5±0.47, 8.4±0.2, 8.3±0.55, 8.6±0.56 and 8.2±0.46 respectively. The south

Table 1: Organoleptic scores of CO1 maize incorporated traditional and ready to use convenience food

Sl No.	Products	Level of incorporation	CO 1 Colour	Appearance	Flavour	Texture	Taste	Overall acceptability
			Traditional foods					
1.	Papad	30	8.5±0.62	8.7±0.58	8.7±0.47	8.4±0.58	8.8±0.68	8.8±0.84
2.	Vadagam	100	8.6±0.67	8.1±0.37	8.2±0.44	8.7±0.50	8.4±0.32	8.4±0.31
3.	Kesari	100	8.8±0.40	8.6±0.49	8.6±0.49	8.1±0.37	8.1±0.34	8.0±0.25
4.	Upma	100	8.7±0.43	8.6±0.49	8.6±0.49	8.3±0.50	8.5±0.50	8.5±0.47
5.	Puliyotharai	100	8.5±0.32	8.2±0.13	8.3±0.16	8.2±0.42	8.7±0.53	8.4±0.21
6.	Vada	75	8.2±0.40	8.5±0.50	8.4±0.41	8.5±0.58	8.6±0.57	8.5±0.49
7.	Idli	50	8.2±0.40	8.5±0.50	8.4±0.49	8.5±0.57	8.6±0.49	8.5±0.50
			Ready to use convenience foods					
8.	Dosa	50	8.1±0.37	8.6±0.50	8.5±0.56	8.5±0.56	8.6±0.62	8.6±0.49
9.	Pakoda	75	8.2±0.40	8.5±0.50	8.4±0.49	8.5±0.50	8.6±0.49	8.5±0.50
10.	Adai	50	8.8±0.40	8.3±0.79	8.6±0.49	7.9±0.54	8.2±0.61	8.6±0.49
11.	Kheer	100	8.1±0.31	8.4±0.82	8.5±0.21	8.7±0.23	8.8±0.54	8.7±0.11
12.	Pittu	75	8.2±0.40	8.5±0.50	8.4±0.49	8.5±0.50	8.6±0.49	8.3±0.49
13.	Nutriball	60	8.3±0.19	8.4±0.18	8.2±0.11	8.8±0.14	8.7±0.14	8.6±0.16

Table 2: Organoleptic scores of HQPM 7 maize incorporated traditional and ready to use convenience food

SI No.	Products	Level of incorporation	HQPM 7					
			Colour	Appearance	Flavour	Texture	Taste	Overall accepta-bility
			Traditional foods					
1.	Papad	30	8.5±0.68	8.3±0.65	8.4±0.49	8.4±0.67	8.5±0.50	8.5±0.57
2.	Vadagam	100	8.2±0.53	8.5±0.46	8.3±0.65	8.5±0.62	8.7±0.46	8.6±0.56
3.	Kesari	100	8.3±0.44	8.1±0.37	8.3±0.54	8.5±0.50	8.6±0.46	8.3±0.55
4.	Upma	100	8.7±0.43	8.4±0.67	8.6±0.56	7.8±0.54	8.2±0.48	8.6±0.56
5.	Puliyotharai	100	8.2±0.44	8.4±0.50	8.0±0.37	8.3±0.67	8.3±0.69	8.2±0.46
6.	Vada	75	8.3±0.43	8.4±0.50	8.3±0.49	8.6±0.50	8.4±0.57	8.6±0.56
7.	Idli	50	8.2±0.42	8.3±0.57	8.4±0.48	8.4±0.52	8.5±0.51	8.5±0.57
			Ready to use convenience foods					
8.	Dosa	50	8.7±0.46	8.5±0.50	8.4±0.49	8.3±0.49	8.2±0.44	8.5±0.50
9.	Pakoda	75	8.6±0.47	8.6±0.49	8.6±0.49	8.2±0.52	8.3±0.49	8.6±0.50
10.	Adai	50	8.6±0.40	8.4±0.79	8.1±0.49	8.9±0.34	8.3±0.65	8.6±0.69
11.	Kheer	100	8.1±0.31	8.6±0.82	8.5±0.21	8.5±0.13	8.8±0.54	8.7±0.18
12.	Pittu	75	8.2±0.40	8.7±0.50	8.3±0.49	8.4±0.20	8.6±0.43	8.3±0.43
13.	Nutriball	60	8.6±0.49	7.6±0.68	8.2±0.40	7.1±0.64	8.3±0.43	8.1±0.57

Note: Values are mean ± SD

Indian breakfast products of idli and vada prepared from 50 and 75 per cent of maize and had the overall acceptability of 8.5±0.50, 8.5±0.49 and 8.5±0.57, 8.6±0.56 respectively in CO1 and HQPM 7 maize varieties. Singh *et al.* (2006) prepared three traditional products *viz*., mathi, pakoda and sev out of yellow maize (HM4). Maize flour was incorporated with about 80 percent in mathi and 40 per cent each in pakoda and sev preparation obtained the mean scores was above 7 for over all acceptability. Siddaraju *et al.* (2008) reported that 30 per cent of winged yam flour incorporated two dehydrated food products *viz*, papad and sandige (dehydrated extruded product) was on par with control with respect to all sensory attributes and had overall acceptability scores of 7.5±0.66 and 6.4±0.67 respectively.

Ready to use convenience foods

Ready to use dosa mix, pakoda mix, adai mix, pittu mix, kheer mix and nutriball mix prepared using both CO1 and HQPM 7 maize flour. Dosa mix and adai mix prepared with 50 and 40 per cent of maize flour respectively. Kheer mix prepared from whole maize grits, pakoda mix and pittu mix made out of 75 per cent of maize flour. For nutri ball 60 per cent of maize flour added with 40 per cent of roasted bengal gram flour. The overall acceptability of CO1 maize incorporated dosa mix, pakoda mix, adai mix, pittu mix, kheer mix and nutriball were 8.6±0.49, 8.5±0.50, 8.6±0.49, 8.3±0.49, 8.7±0.11 and 8.6±0.16 respectively. However the corresponding figures for HQPM 7 maize incorporated dosa mix, pakoda mix, adai mix, pittu mix, kheer mix and nutriball were 8.5±0.50, 8.6±0.50, 8.6±0.69, 8.3±0.43, 8.7±0.18 and 8.1±0.57 respectively. Premakumari *et al*. (2012) reported that 25 per cent incorporation of rice bran in ready to eat mixes *viz.*, chapati, mixed vegetable chapati, wheat dosa, wheat rava idly, adai, rava adai, ragi adai, rice vermicelli, ragi vermicelli and kozhakattai had good acceptability. Yadav *et al.* (2011) formulated the instant mixes using ragi with different proportions. About 60 per cent ragi in dosa mix, 80 per cent in sankati mix (ragi rice balls) and 45 per cent in idli mix were found to be acceptable. Danak and Patel (2011) developed the instant idli mix using parboiled rice (25per cent), ragi (25per cent), kodri (20 per cent) and whole udad (20 per cent) which exhibited good scores in all sensory attributes.

The organoleptic scores of maize flour incorporated extruded foods and bakery foods are presented in the table 3.

Extruded foods

Extruded foods like noodles prepared using 50 per cent of refined wheat flour and 50 per cent of HQPM 7 maize flour had higher overall acceptability (8.6±0.15) compared to noodles from 50 per cent of refined wheat

Table 3: Organoleptic scores of CO1 and HQPM 7 maize incorporated extruded and bakery foods

Products	Level of incorporation	CO 1						HQPM 7					
		Colour	Appearance	Flavour	Texture	Taste	Overall acceptability	Colour	Appearance	Flavour	Texture	Taste	Overall acceptability
Noodles	50	8.1± 0.37	8.8± 0.37	8.1± 0.68	8.5± 0.50	8.4± 0.50	8.4± 0.50	8.2± 0.37	8.3± 0.37	8.5± 0.68	8.5± 0.50	8.2± 0.52	8.6± 0.15
Cookies	50	8.8± 0.40	7.8± 0.74	8.0± 0.18	7.2± 0.29	8.2± 0.21	8.1± 0.17	8.3± 0.40	7.8± 0.74	8.4± 0.18	7.2± 0.39	8.1± 0.27	8.1± 0.34
Bread	20	8.6± 0.49	8.2± 0.44	8.1± 0.34	7.7± 0.50	8.1± 0.34	8.5± 0.42	8.4± 0.49	8.1± 0.44	8.6± 0.34	7.7± 0.50	8.1± 0.31	8.6± 0.13

Note: Values are mean ± SD

flour and 50 per cent CO1 maize flour (8.4±0.50). Balasubramanian *et al.* (2012) suggested that 85 per cent of maize flour and 15 per cent of legume flour namely, black gram, green gram, lentil and peas incorporated extrudates shows the better quality of protein and recommended for the production of low cost instant flour and infant foods. Devi *et al.* (2013) developed ready to eat acceptable extruded products using foxtail millet and maize in the ratio of 60:40.

Bakery foods

Cookies and bread was prepared with acceptability up to the 75 per cent and 20 per cent of maize flour in both the varieties respectively. CO1 and HQPM 7 based cookies had overall acceptability scores of 8.1±0.17 and 8.1±0.34 respectively and also CO1 and HQPM 7 maize substituted bread had scores of 8.5±0.42 and 8.6±0.13 respectively. Rai *et al.* (2012) reported that 25 per cent of maize flour incorporated with wheat flour in bread preparation found to be acceptable. Nazni and Pradeepa (2010) reported that 70 per cent of wheat flour and 30 per cent maize flour incorporated biscuits had an overall acceptability score of 8.60±0.73.

The present study concluded that the HQPM 7 variety maize flour is expected to be better in terms of protein quality since the maize has adequate quantity of the amino acids compared to CO1 maize flour. Maize, the third important cereal contains all the essential nutrients contributing food and nutritional security by meeting energy and protein needs of consumer. The study opens new areas of research since the product development can be scientifically tested and it will help in creating demand by forming a base for commercial product development as a low cost nutritional snack which will have ready market in both rural and urban areas. The feasibility of using maize for preparation of different traditional and non- traditional foods provides health benefits and also wide scope of initiation of maize based rural entrepreneurship.

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