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RESEARCH PAPER

Value added products from quality protein maize: An opportunity to generate rural employment

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Abstract 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, maize has an inbuilt drawback of being deficient in two essential amino acids. Conventional breeding efforts have yielded several modern maize varieties referred as Quality protein maize (QPM). 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 nine point hedonic scale and also estimated the nutrient composition of the products. Results of sensory evaluation showed the overall acceptability of the products prepared from HQPM 7 maize variety compared to the conventional variety of CO1. The nutrients composition also higher in the HQPM 7 maize based products compared to CO 1 maize based products. The maize based products created new avenue to formulate ready to eat and ready cook products from maize with sufficient nutrients for women entrepreneurship

Keywords: Hybrid maize • QPM • Product development • Commercialization

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Introduction

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 (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 and developed the maize mutants with high levels these amino acids in the endosperm protein. Which are collectively called quality protein maize (QPM) (Milan-Carrillo *et al.,* 2004). International Maize and Wheat Improvement Center (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.

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 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, Community 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.

Nutrient composition maize flour

The nutrient composition of the maize flour obtained from CO 1 and HQPM 7 was evaluated using standard methods. The percentage of moisture content by moisture evaporation method, crude protein by Kjeldahl digestion method, soxhlet Solvent extraction method was employed for fat. The ash and fibre content were estimated by dry ashing (AOAC, 2005) and acid and alkali method (AOAC, 2020) respectively. The free fatty acid and peroxide value of the products were estimated by titration method (AOAC, 1995) and minerals were estimated by the Atomic absorption spectrometry meter (Ikujenlola *et al.*, 2018)

Processing of value added products from maize

The CO1 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. Sensory evaluation was performed by panel of 50 trained members using 9-ponit hedonic (Subbulakshmi and Amutha, 2013). All the panelists were from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu and Informed consent was obtained from all individual participants included in the study. All procedures performed in studies involving human participants were in accordance with Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu India ethical standards and the committee has confirmed that no ethical approval is required. All the maize based products were served using codes immediately after preparation for sensory evaluation. The above selected panelists are familiar with the standard parameters which assisted them for the sensory analysis of the products. The panels were asked to evaluate and score for the appearance and colour, flavour, texture, crispness, taste and overall palatability. The scale range used was 1 = dislike extremely, 9 = like extremely.

Results and discussion

Nutrient composition of maize flour

The nutrient composition of two maize varieties, CO1 and HQPM 7 maize flour (Table 1) and illustrates as heatmap (Figure 1). The major nutrient of maize flour is starch available in the form of amylose, and amylopectin which are prominent (green shades) confirming maize as a carbohydrate rich grain. The fiber content is also moderate, supporting the digestive benefits. The clustering suggests similarities in nutrient composition between CO1 and HQPM 7, with slight variations in protein, phosphorous, and starch content, indicating that HQPM 7, as a Quality Protein Maize (QPM) variety, may have a slightly enhanced nutritional profile compared to CO 1 maize varieties. With respect to mineral composition potassium and phosphorous as the most abundant nutrients (red shades) and essential micronutrients like calcium, zinc, iron, magnesium, and copper are present in moderate amounts contributing to the nutritional value. The low peroxide value and free fatty acid content indicate minimal fat oxidation, ensuring good storage stability.

Table 1. Chemical compositions of maize varieties (per 100g)

Parameters	CO 1	HQPM 7
Moisture (g)	9.30	10.10
Protein (g)	12.63	12.15
Fat (g)	4.60	5.20
Starch (g)	68.66	67.89
Fiber (g)	2.60	2.70
Ash (g)	1.50	1.30
Free fatty acid (mg KOH/g)	5.30	5.70
Peroxide value (meq P/kg)	7.80	8.10
Amylose (g)	38.26	39.52
Amylopectin (g)	33.02	30.72
Niacin (mg)	3.60	2.70
Tryptophan (mg)	38	63
Iron (mg)	2.60	2.70
Copper (mg)	0.36	0.41
Zinc (mg)	2.20	2.80
Magnesium (mg)	124	121
Potassium (mg)	287	289
Calcium (mg)	8.0	9.0
Phosphorous (mg)	314	348

Processing of value added products from maize

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 Table 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±0.31and 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 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.

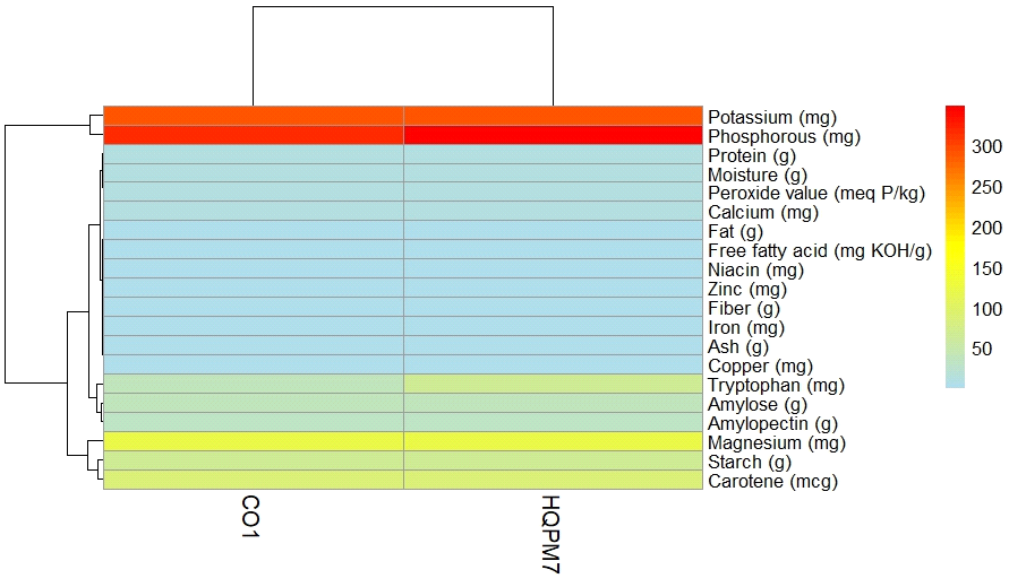

Figure 1. Heat map of Nutrient composition of CO 1 & HQPM 7 maize flour

Table 2. Organoleptic scores of CO1 and HQPM 7 maize incorporated traditional and ready to use convenience food

Products	Level of incorpo-ration	CO 1						HQPM 7					
		Colour	Appearance	Flavour	Texture	Taste	Overall acceptability	Colour	Appearance	Flavour	Texture	Taste	Overall acceptability
Traditional Foods													
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	8.5±0.68	8.3±0.65	8.4±0.49	8.4±0.67	8.5±0.50	8.5±0.57
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	8.2±0.53	8.5±0.46	8.3±0.65	8.5±0.62	8.7±0.46	8.6±0.56
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	8.3±0.44	8.1±0.37	8.3±0.54	8.5±0.50	8.6±0.46	8.3±0.55
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	8.7±0.43	8.4±0.67	8.6±0.56	7.8±0.54	8.2±0.48	8.6±0.56
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	8.2±0.44	8.4±0.50	8.0±0.37	8.3±0.67	8.3±0.69	8.2±0.46
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	8.3±0.43	8.4±0.50	8.3±0.49	8.6±0.50	8.4±0.57	8.6±0.56
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	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													
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	8.7±0.46	8.5±0.50	8.4±0.49	8.3±0.49	8.2±0.44	8.5±0.50
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	8.6±0.47	8.6±0.49	8.6±0.49	8.2±0.52	8.3±0.49	8.6±0.50
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	8.6±0.40	8.4±0.79	8.1±0.49	8.9±0.34	8.3±0.65	8.6±0.69
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	8.1±0.31	8.6±0.82	8.5±0.21	8.5±0.13	8.8±0.54	8.7±0.18
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	8.2±0.40	8.7±0.50	8.3±0.49	8.4±0.20	8.6±0.43	8.3±0.43
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	8.6±0.49	7.6±0.68	8.2±0.40	7.1±0.64	8.3±0.43	8.1±0.57

Values are mean ±SD

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, ravaadai, 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 (25%), ragi (25%), kodri (20%) and whole udad (20%) which exhibited good scores in all sensory attributes.

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

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
Extruded foods													
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
Bakery foods													
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

Values are mean ±SD

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.

Conclusion

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 developed products were commercialized in the departmental stores. The nutritional importance of the formulated products processing was explained to the consumers at the time of sale and people bought the products with interest and the production had good demand. 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 nontraditional foods provides health benefits and also wide scope of initiation of maize based rural entrepreneurship.

References

Adebowale, A. A., Sanni, S. A., Karim, O. R. & Ojoawo, J. A. (2010). Malting characteristics of ofada rice: chemical and sensory qualities of malt from ofada rice grains. *International Food Research Journal,* **17**: 83-88.

AOAC, Official Method of Analysis. (1995). 16th *edn*. Association of Official Analytical Chemists. Washington.

AOAC. Official methods of analysis. (2000). 17th *edn*. Association of Official Analytical Chemists International. Washington, DC.

AOAC. Official Methods of Analysis. (2005). 11th *edn*. Association of Official Analytical Chemists. Washington, DC.

Balasubramanian, S., Borah, A. & Anand, T. (2012). Altering pasting characteristics of selected dehulled legumes incorporated rice and maize extrudates. *Beverage and Food World,* **39**(4): 44-46.

Danak, T. & Patel, T. (2011). Development of instant idli mix using underutilized grains. In Proceedings of 44th National Conference, Nutrition society of India. November 16-17th 2012. Thirupathi. Andhra Pradesh. pp. 131.

Devi, S. G., Palanimuthu, V., Sandeep, T. N. & Kumar, A. H. S. (2013). Development of foxtail millet based ready to eat (kurkure type) hot extruded product. In Proceedings of 3rd INCOFTECH-2010. International Conference on Food Technology. Indian Institute of Crop Processing Technology. 4-5th January 2013. Thanjavur. Tamil Nadu. India. pp. 204.

Ikujenlola, A. V. & Ogunba, B. O. (2018). Potential complementary food from quality protein maize (*Zea mays* L.) supplemented with sesame (*Sesamum indicum*) and mushroom (*Oudeman siellaradicata*). *Journal of Nutrition & Food Science,* **8**(3): 1–7.

Milan-Carrillo, J. A., Gutierrez-Dorado, R., Cuevas-Rodriguez, O. G., Garzon-Tiznado, J. A. & Reyes-Moreno, C. (2004). Nixtamalized flour from quality protein maize (*Zea mays* L). optimization of alkaline processing. *Plant Foods for Human Nutrition*, **59**: 35–44.

Nazni, P. & Pradeepa, S. (2010). Organoleptic evaluation of biscuits prepared from potato flour. *Beverage and Food Word,* **37**(4): 31-34.

Nuss, E. T. & Tanumihardjo, S. A. (2010). Maize: A paramount staple crop in the context of global nutrition. *Comprehensive Reviews in Food Science and Food Safety,* **9**: 417-435.

Premakumari, S., Balasasirekha, R., Gomathi, K., Supriya, S., Jagan Mohan, R. & Alagusundram, K. (2012). Development and acceptability of fibre enriched ready mixes. *International Journal of Pure and Applied Sciences and Technology*, **9**(2): 74-83.

Rai, S., Kaur, A., Singh, B. & Minhas, K. S. (2012). Quality characteristics of bread produced from wheat, rice and maize flours. *Journal of Food Science and Technology*, **49**(6): 786-789.

Shobha, D., Pradannakumar, M. K., Puttaramanaik. & Sreemastty, T. A. (2011). Effect of antioxidant on the shelf life of quality protein maize flour. *Indian Journal of Fundamental and Applied Life Sciences,* **1**(3): 129-140.

Siddaraju, N. S., Ahmed, F. & Urooj, A. (2008). Effect of incorporation of *Dioscorea alata* flour on the quality and sensory attributes of Indian dehydrated products. *World Journal of Dairy and Food Sciences,* **3**(2): 34-38.

Singh, V., Kawatra, A. & Sehgal, S. (2006). Proximate composition & mineral (Fe, Ca, Zn and Mg) constituents in maize based traditional Indian food products. *Journal of Food Science and Technology*, **16**(3): 153-159.

Subbulakshmi, B. & Amutha, S. (2013). Quality protein maize for nutritional security. *Asian Journal Home Science*, **8**(2): 566-569.

Yadav, M., Lalithakala, K. & Ravinder, A. (2011). Studies on preparation of different instant mixes and biscuits of *Eleusine coracan.* In Proceedings of 43rd National Conference, Nutrition society of India. November 11-12th 2011. Hyderabad. Andhra Pradesh. pp. 119.