Research Article

Physicochemical Analysis of Maize grown under Organic and Conventional Management and its Value Added Products

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Abstract

Agriculture is an important sector of the Indian economy. About half of the population relies on agriculture, as it is the principal source of income. From last 3 decades the use of pesticides for increasing the crop production is also increased. After green revolution increased demand of food and increased use of pesticides causes certain cancers. Combating from small allergies to cancer is a challenge for the new generation. In this paper emphasis gives on shift from pesticides to organic management of agriculture. The single variety of Maize (*Zea Mays L)* variety Pratap QPM Hybrid-1 of different treatment is used to compare nutritional composition and as a value added product namely Maize Chapatti. Due to different crop management flour was not enriched with other flours as it changes the original sensory values. Organic and conventional management included two samples of each. Organic sample named as (OSM and OIPM) for 100% organic samples and 75 % organic + 25% innovative practices and inorganic samples named as (IOSM and SRM) for 100% inorganic and state recommendations respectively. Results showed that the moisture content (15.33%), crude protein content (6.85 g/100g) and crude fibre content (1.46 %) was found highest in organic samples respectively. Phytic acid content (2.21mg/g) was found lowest in inorganic samples of maize. Total anti-oxidant content (587.70 mg TE/100g) of maize was observed highest in inorganic samples. The Chapatti was standardized through sensory evaluation by trained members of the panel on 9-point hedonic rating scale. Sensory evaluation showed that Chapatti prepared from OSM was highly accepted as it has scored high in all scores followed by OIPM, OISM and SRM management of maize flour.

Keywords: Organic, conventional, management, Maize, Nutritional characteristics, Sensory characteristics

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Introduction

Human beings have three basic necessities like food, shelter and clothing but food is the most important to live. Wheat and maize is staple food crop of India. Rice, wheat and maize are important cereal crops of the nation which fight from hidden hunger in all aged group of people. About sixty per cent of energy fulfilled through carbohydrates. Earlier traditional practices of farming were performed but due to natural calamities like droughts, pests' infestation and improper technique gave rise to malnutrition.

During independence due to low availability of food India used to import cereals like wheat, rice to fulfil people's demand. After 1960's a movement called Green Revolution came and brought better techniques to cultivate crops and led to increase food yielding capacity. This included methods which were supported by fertilizers and pesticides. But due to over use of chemical fertilizers and pesticides various problem were faced by Indians. People understood that over use of chemical fertilizers brought harm to soil salinity and made it infertile as well as it adversely affects humans and animals health. So there was a gradual increase in demand of organic farming. However, this paper deals with the compilation of findings and their interpretations.

Materials and Methods

Locale of the study

The study was conducted in the Laboratory of Foods and Nutrition, CCAS, RCA and CTE, MPUAT, Udaipur.

Selection and procurement of sample

One staple cereal food crops of Rajasthan namely Maize (*Zea Mays L)* variety Pratap QPM Hybrid-1 of "organic, and conventional management" was purposively selected for the study purpose from the Rajasthan College of agriculture,

under the Network Project on Organic Farming, MPUAT, Udaipur. For this purpose sample of maize of different crop management was named as 100 % organic sources (OSM), 75 % organic +25 % innovative practices (OIPM), 100 % inorganic nutrient sources (IOSM) and state recommendation (SRM). To avoid varietal difference single lot of wheat was collected and analysed in triplicate for the nutritional and sensory evaluation.

Results and Discussion

Nutritional composition

Proximate composition, anti-nutritional factors like phytic acid, total anti-oxidant content were analysed from the obtained flour of "organic, and conventional management" using standard methods. Results of Nutritional characteristics were presented in **Table 1** and discussed below:

Table 1 Mean±SD Proximate Analysis of "organic, integrated and conventional management" Maize flour

Samples	Moisture (%)	Fat (g/100g)	Crude Protein (g/100g)	Ash (g/100g)	Crude Fibre (%)	Carbohydrates (g/100g)	Energy (Kcal)
OSM	15.33±1.03	2.40±0.14	4.96±0.46	1.43±0.00	1.36±0.03	74.52±5.01	339.52±12.14
OIPM	14.60±0.49	2.60±0.19	6.85±0.36	1.48±0.06	1.46±0.05	73.74±4.39	342.84±0.05
IOSM	13.67±0.24	4.80±0.08	6.56±0.11	1.53±0.04	0.53±0.00	70.86±1.23	352.88±1.08
SRM	14.00±0.34	3.60±0.09	5.11±0.12	1.510±	1.11±0.03	74.67±1.80	351.52±1.39
SEm±	0.31	0.07	0.15	0.025	0.016	1.78	2.57
CD at 5 %	0.92	0.21	0.45	0.075	0.048	5.28	7.63

Proximate Composition

Moisture

Moisture content in maize flour varied from 13.67 % to 15.33 % in the selected maize samples. Highest moisture content of 15.33 % in OSM (100 % organic sources) whereas lowest of 13.67 % in 100 % inorganic samples of Maize. The findings obtained in the present study suggested that the moisture content of the samples obtained from OIPM (75 % organic + 25 % innovative practices, 14.60 %) and SRM (state recommendation 14.00 %) was as per the recommended level of moisture content of 14 % whereas other samples were having lower or higher moisture content as compared to recommended level. The 100 per cent organic samples were significantly higher (P≥ 0.05) in moisture content. Hence variation in moisture attributed to factors like environmental factors, variety and agronomical samples which affect the keeping quality of the cereals. Similar study was reported by Qamar *et. al.* (2017) that the moisture contents of commercial white and non-commercial yellow maize flours were 9-19% (Enyisi *et al.,* 2014a; Enyisi *et al*., 2014b; Trabelsi *et al*., 1998) though, moisture contents in yellow maize flour are higher than of commercial white maize flours. The variation of moisture contents in both maize flours may be attributed different factors such as agronomic, environmental factors and the maize variety.

Fat content

Fat content ranged from 2.40g to 4.80 g/100 g of in maize flour samples (Table 1). But for maize highest fat content of 4.80 g in SRM (state recommendation) followed by 3.60 g in IOSM (100% inorganic nutrient sources) and 2.60 g in OIPM (75 % organic + 25 % innovative practices) respectively. Hundred per cent inorganic samples of maize was observed significantly higher amount of fat as compare to organic management. Hence, SRM sample of maize have fat content lower than the organic management which shows that organic cereals may be recommended for weight reducing regimes. Saeed *et.al.* (2013) suggested that the variation in fat content of the samples of maize crops grown from farm yard and mulching has crude fat of 4.50 and 4.19%, respectively. Although the cost on hand weeding and mulching is high and may not be desirable to be practiced by the maize growers but for the cultivation of organic crops farmyard manure was the desirable mulching practice for enhancing crude fat level of grains.

Crude protein

Protein content of maize ranged from 4.96g to 6.85 g/100 g. The highest protein content was observed in OIPM of 6.85 g/100 g (75 % organic + 25 % innovative practices) followed by 5.11 g in SRM (state recommendation) respectively. In maize OSM sample had the least content of crude protein. Results showed that OIPM observed significantly higher content of protein (P≥ 0.05) among "organic and conventional management". The significant difference was observed among "organic and conventional management" of maize samples. It was found that

variation in protein content of the samples both in wheat and maize may be due to the use of different agricultural practices for growing organic and inorganic wheat and maize crops. For the cultivation of crops under organic conditions it may be the contribution due to fermentation with waste products of animals i.e. buttermilk, cow urine and water in the ratio 1:1:10 and also FYM was used during cultivation of crop (Modgil *et. al*. 2017). This might have resulted in as increase in protein content of organic wheat.

Ash

In maize flour ash content was ranged from 1.43 g to 1.53g/100g. The highest ash content of 1.53 g in IOSM (100 % inorganic nutrient sources) followed by 1.51 g in SRM (state recommendation) and 1.48 g in OIPM (75 % organic + 25 % innovative practices) respectively. In the present study OSM (hundred per cent organic) maize flour was observed (P≥0.05) significantly higher ash content than other samples. Similar study was observed by Modgil *et.al.* (2017) reported that organic wheat has higher ash content (2.06%) and inorganic wheat has lower ash content (1.76 %).

Crude fibre

In maize it ranged from 0.53 per cent to 1.46 per cent. Similarly to wheat it found highest in 1.36 in OSM (100 % organically grown) followed by 1.11 in SRM (state recommendation), Organic samples of maize significantly higher (P≥ 0.05) as compared to conventional management which might be due to the reason of hardness of seeds. Similar findings were reported by Modgil *et. al* (2017) in which the crude fibre content ranged from 1.71 per cent to 1.67per cent in organic and inorganic samples respectively.

Carbohydrates

In maize it ranged from 70.86g to 74.67 g. The highest carbohydrates of 74.67 g in SRM (state recommendation) followed by 74.52 g in OSM (100 % organic nutrient sources) and 73.74 g in OIPM (75 % organic + 25 % innovative practices) respectively. Results indicated that inorganic samples were significantly higher (P≥ 0.05) in carbohydrates content from organic management maize.

Energy

In maize it ranged from 339.52 kcal to 352.88 kcal. The highest energy content of 352.88 kcal in IOSM (100 % inorganic nutrient sources) followed by 351.52 kcal in SRM (state recommendation) and 342.84 kcal in OIPM (75 % organic + 25 % innovative practices) respectively. The lowest amount of energy was calculated in organic practices of maize.

Phytic acid

It ranged from 2.21 mg/g to 2.73 mg/g in maize flour. The content obtained in maize flour was lower than the normal range. The highest amount of phytic acid of 2.73 g observed in OSM (100 % organic nutrient sources) whereas it was found lowest in 2.21 mg in IOSM maize. The phytic content was found significantly (P≥ 0.05) lower of 2.21 mg in IOSM in maize samples (**Table 2**). The phytic acid content is observed to reduce with the recommended level of processing; hence, it is believed to be highest in refined flours as compared to the whole flours. The loss of phytic acid varies from 18.1 to 46.6 per cent for fresh maize and from 11.5 to 52.6 per cent for dry maize respectively [4].

Table 2 Phytic acid content in Maize flour

Samples	Phytic acid (mg/g) of Maize Flour
OSM	2.54±0.23
OIPM	2.73±0.14
IOSM	2.21±0.34
SRM	2.60±0.06
SEm±	0.07
CD at 5 %	0.20

Total anti-oxidant content

In maize total anti-oxidant content was ranged from 343.35 mgTE/100 g to 587.70 mgTE/100 g. Similar to wheat, in maize it was observed lowest of 343.35 mgTE/100 g in OSM. The highest total anti-oxidant content of 587.70 mgTE/100 g was observed SRM. An inorganic sample of maize was significantly higher ($P \geq 0.05$) amount of anti-oxidant content as compare to organic samples (**Table 3**). Similar results were showed by Siyuan *et.al.* (2018) that corn has maximum total anti-oxidant activity (181.4±0.86 µmol of vitamin C equi/g of grain) among cereal grains like rice, oats and wheat. Phytochemicals are the foremost providers to the total anti-oxidant activity in corn.

Table 3 Total Anti-oxidant content of Maize flour

Samples	Antioxidant (mgTE/100g) maize
OSM	343.35±31.53
OIPM	432.45±17.02
IOSM	481.05±11.57
SRM	587.70±15.59
SEm±	10.12
CD at 5 %	30.06

Development of Recipes

The selected samples of wheat and maize of six agro management Samples were put to develop most commonly consumed products to judge the organoleptic acceptability of the flours. The products developed were; Chapatti and Dalia. Recipes were not enriched with any other flour or substances as enrichment may change their original taste and quality except little amount of ghee and salt to taste were used. The recipes were standardized after 3-4 trials. The results of the developed recipes are presented in **Table 4** discussed below.

Table 4 Water for dough formation, dough weight and cooked weight of Maize Chapatti:

Samples	Water for dough formation (ml)	Dough weight (g)	Cooked weight (g)
OSM	35	89.5	67.5
OIPM	40	82.0	74.5
IOSM	35	89.5	67.5
SRM	28	85.5	71.5

Standardization of Recipes

For the preparation of maize chapatti; 50 g flour was taken. To develop taste and flavour 2 g of salt was added before dough formation and 3-4 g ghee was spread on the prepared chapatti. Maize flour chapatti prepared from OSM and IOSM required equal amount of water i.e. 35 ml and dough weight was found to be highest in both (89.5 g). Cooked weight of maize flour chapatti ranged from 64.5 g to 74.5 g. The highest cooked weight of maize flour chapatti was 74.5 g in OIPM whereas the lowest cooked weight 67.5 g found in OSM&IOSM. However, the highest amount of water i.e. 40 ml in OIPM indicated that the OIPM maize flour chapatti might be higher in protein and fibre content (Table 4).

Figure 1 Developed Maize Chapatti of "organic and conventional management" flour

Figure 2 Sensory Evaluations of Developed Recipes

Acceptability of recipes using sensory evaluation

Acceptable sensory attributes have been recognized to come to a decision feature in the acceptance and satisfaction of referred by panellists and have an edge over other similar important dietary and protection aspect. Therefore, the developed recipe of maize was subjected to sensory evaluation (colour, taste, flavour, texture, appearance, consistency, doneness and overall acceptability) on nine point hedonic rating scale (Williams, 1989) by panel of 10 members. Sensory scores as assigned by panel members for individual sensory attributes and overall acceptability were statistically analysed and are presented in Table 3 for products Maize Chapatti.

Maize Chapatti

In the present study maize chapatti was prepared and score assigned for sensory attributes by panel members are presented in Table 2. Highest scores for colour was assigned to OSM (8.27±0.28) followed by OIPM (8.00±0.07) SRM (7.50±0.41) respectively. Least score for colour was assigned to IOSM samples of maize chapatti. Chapatti prepared from OSM flour was found most acceptable for taste (8.13±0.27) as compared to OIPM, and SRM and "liked moderately" whereas IOSM (6.80±0.35) "liked slightly". Sensory evaluation of flavour OSM chapatti revealed the highest score (8.10±0.18) amongst other Samples of maize. Sensory score of texture was observed highest for OIPM (8.30±0.12) was "liked very much" whereas OSM (7.73±0.18), IOSM (7.13±0.21) and SRM (7.00±0.18) was "liked moderately". Appearance of OSM (8.13±0.237) chapatti was "liked very much" and OIPM (7.93±0.18), SRM (7.30±0.22), IM1 (7.26±0.11) and IOSM (7.20±0.18) were "liked moderately". Doneness of OSM chapatti (7.84±0.18) found highest and followed by OIPM, was liked moderately but IOSM (6.94±0.21) and SRM (6.90±0.18) "liked slightly" Overall acceptability of OSM chapatti was highest as compared to others. Sensory evaluation of maize chapatti revealed that OSM was most acceptable among all Samples. There was observed a significant difference (P≥ 0.05) between all six agro Samples (**Table 5**). According to Dholakia and Shukul (2015) a study was conducted to compare the quality of food like cereals pulses, roots fruits, vegetables and jaggery in terms of taste, flavour, aroma, texture, etc. They found that in all attributes organic food was better than non-organic food items.

Table 5 Mean±SD Sensory Characteristics of Developed Recipe Maize Chapatti

Samples	Colour	Taste	Flavour	Texture	Appearance	Doneness	Overall
OSM	8.27±0.28	8.13±0.27	8.10±0.18	7.73±0.18	8.13±0.27	7.84±0.18	7.90±0.20
OIPM	8.00±0.07	7.77±0.55	7.43±0.11	8.30±0.12	7.93±0.18	7.70±0.11	7.80±0.56
IOSM	7.33±0.28	6.80±0.35	7.27±0.22	7.13±0.21	7.20±0.18	6.94±0.21	7.00±0.36
SRM	7.50±0.41	7.00±0.38	7.20±0.19	7.00±0.18	7.30±0.22	6.90±0.18	7.13±0.39
SEm±	0.14	0.19	0.10	0.10	0.11	0.10	0.18
CD at 5 %	0.44	0.59	0.31	0.31	0.33	0.30	0.54

Conclusion

In maize samples moisture content, crude protein content and crude fibre content was found highest in organic samples of maize. Anti-nutritional factors phytic acid content obtained in maize flour was lower than the normal range. Total anti-oxidant content in maize was observed highest in inorganic samples of maize (State

Recommendation). Maize chapatti was highly accepted by the member of panel but most acceptable and highest scores were obtained for recipes developed from organic management. The particular variety of maize (*Zea Mays L)* Pratap QPM Hybrid-1 was observed superior in nutritional and sensory characteristic hence this may be suggested for nutritional enhancement as well as better sensory attributes.

References

[1] J. Dholakia and M. Shukul. Sensory Evaluation Test of Organic and Non- Organic Food. Journal of Environment Research and Development. 2015. 9(3A), 857-863.

[2] I. Enyisi, V. Umoh, C. Whong, I Abdullahi and O. Alabi. Chemical and nutritional value of maize and maize products obtained from selected markets in Kaduna State, Nigeria. African Journal of Food Science & Technol., 2014a 5(4): 100-104.

[3] I.S. Enyisi, V. Umoh, C. Whong, O. Alabi and I. Abdullahi. Chemical and nutritional values of maize and maize products obtained from selected markets in Kaduna. J. Pharmaceutical & Allied Sciences. 2014b. 11(2): 2106-2113.

[4] M. Guttieri, K Peterson, E.J. Souza. Milling and baking quality of low phytic acid wheat. Crop Science. 2006. 46:2403–2408. doi: 10.2135/cropsci2006.03.0137.

[5] R. Modgil, N. Kumari, and S. Devi. Comparative analysis of physical and chemical characteristics of organic and inorganic wheat. Himachal Journal of Agricultural Research. 2017. 43(2): 112-116

[6] S. Qamar, M.,Aslam, F. Huyop And A. M. Javed. Comparative Study for the Determination of Nutritional Composition in Commercial and Non-commercial Maize Flours. Pakistaan Journal of Botany. 2017. 49(2): 519-523.

[7] M. Saeed, S. Ullah, Z. Shah, M. Iqbal, M. Waqas, M. Haroon, and U.H. Shah. Proximate Composition and Mineral Content of Maize Grains Influenced by Mulching. Pakistan Journal of Weed Science and Research. 19(3): 349-355.

[8] S. Siyuan, L. Tong and R. Liu. Corn phytochemicals and their health benefits. Journal of Food Science and Human Wellness. 2018. 7(3): 185-195.

[9] S. Trabelsi, A.W. Kraszewski and S.O. Nelson. Nondestructive microwave characterization for determining the bulk density and moisture content of shelled corn. Measurement Science & Technology. 1998. 9(9): 1548.

[10] M. Williams. Objective evaluation in Food Experimental Perspectives. II ed. Mac. Millan Publishing Company, New York: 1989. 80.

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