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Analysis of nutritional composition of popular maize varieties

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Abstract
Maize is one of the most widely consumed cereal crops in India. It is the third most important food crop in India after rice and wheat. It serves as an important source of carbohydrate in both human and livestock diet for release of energy needed for normal body metabolism. In this research four different maize varieties namely VQPM-9, VLQPMH-59, PHM-3 and PM-9 were analysed for their proximate contents. In the research it was found that the significantly maximum value 4.00 percent for moisture content was observed in PM-9 while the least value for moisture content was recorded in VLQPMH-59 with 3.40 percent. Maximum value for fat content was found in variety VQPM-9 with 4.11 percent fat content and lowest fat content was observed in variety PM-9 with 1.11 percent fat content. The maximum value for protein content 13.81 percent was detected in variety PHM-3 and the minimum value for protein content was observed in VLQPMH-59 with 5.63 percent protein content. Maximum value for crude fibre content was noticed in variety VLQPMH-59 with 2.26 percent crude fibre content and PM-9 had the least fibre content 1.44 percent. No significant difference was observed in the ash content of the four maize varieties and the average content was found to be 1.47 percent. The highest value 84.71 percent for carbohydrates content was observed in the maize variety VLQPMH-59 and least carbohydrates content was present in PHM-3 i.e., 77.06 percent. From the analyses it can be concluded that maize varieties are nutrient dense and can be made a part of diet.

Keywords: Cereals, QPM, nutrient rich, normal maize, diet

1. Introduction

Cereals are the most widely cultivated and consumed crops globally (Enyisi *et al*., 2014) [5]. They make up a significant proportion of calories in the human diet and cover more than half of the world's cropland area (approximately 45% and 54%, respectively, at the global scale (FAOSTAT, 2017) [6]. Low-income populations obtain a greater percentage of calories and nutrients from cereals (Srivastava *et al*., 2013) [12].

Maize (*Zea mays* L.) is one of the most versatile and emerging cereal crops having wider adaptability under varied agro-climatic conditions. It is of the family Poaceae and is a staple food in many countries around the world (Shah *et al*., 2016) [10]. The domestication and diversification of maize by native farmers is considered as one of the greatest achievements of plant breeding. Archaeological records suggest that maize was first brought into cultivation in Mexico and Central America (Singh & Kumar, 2016) [11]. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. It is important as a staple food and has wide industrial applications such as production of high fructose corn syrup (Shah *et al*., 2016) [10].

Maize is known by various names such as zea, silk maize, makka. barajovar, etc. Maize kernel is an edible and nutritive part of the plant. It contains vitamin C, E, K, B1 (thiamine), B2 (niacin), B3 (riboflavin), B5 (pantothenic acid), B6 (pyridoxine), folic acid, selenium. N-p-coumaryl tryptamine, and N-ferrulyl tryptamine. The two main forms of vitamin E present in our diet are alpha and gamma tocopherols. Maize oil is amongst the rich sources of these tocopherols, especially gamma tocopherol. Potassium is a major nutrient present which has a good significance because an average human diet is deficient in it. Maize silk contains various constituents essential for our diet such as mefenamic acid, fixed oils, resin, sugar, mucilage, salt, and fibers (Kumar and Jhariya, 2013) [7].

In India, maize is the third most important food crop after rice and wheat. It is a multipurpose crop providing food and fuel for human beings and feed for cattles, its grains can be consumed in various ways such as boiling, roasting, fried or popped. (Afzal *et al*., 2009) [2].

Since it a crop of great importance both economically and nutritionally the present study aims at finding the nutritional composition of some of the popular varieties of maize in India.

2. Material and Methods: Four varieties of maize were procured from two different sources. VQPM-9 (Biofortified) and VLQPM Hybrid-59 (Biofortified) were procured from ICAR- Vivekanand Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, Uttarakhand. Pratap Hybrid Maize-3 (PHM-3) and Pratap Makka-9 (PM-9) were procured from Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur based on their availability. Flour of all the varieties was prepared separately and proximate analysis was conducted according to the standard procedures (NIN, 2003) [14].

2.1 Determination of Moisture Content

Moisture is one of the most important components of food. The moisture content of any food is ascertained not only to analyze the chemical composition of food material on a moisture-free basis, but also to evaluate the product's shelf life. In a dried and weighed petri dish, a 10 g sample was weighed. The petri dish with sample were weighed at regular intervals until a constant weight was obtained. The percentage of moisture was calculated using the following formula:

$$\text{Moisture (g/100g)} = \frac{\text{Initial weight (g) - Final weight (g)}}{\text{Weight of the sample (g)}} \times 100$$

2.2 Determination of Protein Content

The protein content was calculated by measuring the nitrogen content of the sample using the Micro Kjeldahl Method. The protein content of the products was calculated by multiplying the nitrogen content of the material by a factor of 6.25 (General factor). Three hundred milligram of moisture-free sample were digested with 3 g of digestion mixture (5:1 K_2SO_4+$CuSO_4$) and 10 ml of concentrated H_2SO_4 until the contents became clear. The digested sample was then diluted with 50 mL of distilled water before being made alkaline with 40 mL of NaOH (40 percent). The ammonia liberated during distillation was collected in a 250 ml conical flask containing 25ml of 4 percent boric acid and two drops of indicator.

Then the solution was titrated against 0.1 N HCl. The nitrogen content is determined using the following formula:

$$\text{Percent Nitrogen} = \frac{\text{ml HCl in determination- ml blank)} \times \text{Normality of HCI}}{\text{Weight of the sample}} \times 100$$

(Crude protein content (g) = Percent Nitrogen *6.25

2.3 Determination of Crude Fat Content

The fat content of the maize samples was estimated as crude ether extract of moisture free samples using the Soxhlet's Extraction Method on Socs Plus System. A thimble was filled with a weighed amount of moisture-free sample (5 g) and placed in the thimble holder, which was placed in an already weighed beaker, and 80 ml petroleum ether (60-80 °C) was poured into the beaker. The system was loaded with beakers, and the temperature was set to 100 °C. After 120 minutes of operation, the temperature was raised to the recovery temperature, which was twice the initial boiling temperature. Rinsing was thus performed twice to collect any remaining fat in the sample. Beakers were removed and placed in a hot air oven. The beakers were weighed after the thimble holders were removed. The fat content of the sample was determined using the following formula:

$$\text{Fat (g/100g)} = \frac{\text{Weight of ether extract fat (B-A)}}{\text{Weight of sample (gm)}} \times 100$$

Where,
A= Weight of empty flask (g)
B= Weight of flask+ fat (g)
B-A = Weight of fat (g)

2.4 Determination of Ash Content

The ash content in foods is the inorganic residue that remains after the organic matter is burned. Total ash estimation is a measure of the total mineral content of the food. In a previously heated, cooled, and weighed crucible, a 5 g moisture-free sample was weighed. After completely charring the sample on the hot plate, it was heated in a muffle furnace at 600 °C for 5 hours. The crucible was then allowed to cool in a desiccator and weighed. The process was repeated until the ash obtained was almost white or greyish in color and had a constant weight. The ash content of samples was determined using the following formula:

$$\text{Ash (g/100 g)} = \frac{\text{Weight of ash (g)}}{\text{Weight of sample taken (g)}} \times 100$$

2.5 Determination of Crude Fibre

The acid alkali digestion method was used to determine the fibre content. Fibre is an insoluble vegetable matter that cannot be digested by proteolytic or diastatic enzymes and can only be used through microbial fermentation. It is typically made up of cellulose, hemicelluloses, and lignin. The method for estimating crude fibre used was- three grams of moisture and fat free sample was placed in a 500 ml beaker and boiled for thirty minutes with 200 ml of 1.25 percent sulphuric acid. By adding hot distilled water during the boiling process, the volume was kept constant. This was filtered using muslin cloth, and the residue was rinsed with hot distilled water until it was acid-free. After that, the residue was transferred to the same beaker and boiled for 30 minutes with 200 ml of 1.25 percent sodium hydroxide solution. After boiling, the samples were filtered through muslin cloth, and the residue was rinsed with hot distilled water until free of alkali, then washed with 50 ml alcohol and ether. Then the residue was taken into the crucible (W1) and then dried in an oven at 130 °C for 2 - 3 hours, cooled, and weighed (W2). Crucible with dried residue was ignited in a muffle furnace at 600 °C for 2-3 hours till it was turned to ash, then cooled and weighed again (W3). The following formula was used to calculate crude fibre:

$$\text{Percent crude fibre} = \frac{(W2 - W1) - (W3 - W_1)}{\text{Weight of sample}} \times 100$$

Where,
W1= Weight of empty crucible
W2= Weight of crucible with dry residue

W3= Weight of crucible with heated residue

2.6 Determination of Carbohydrate
Total carbohydrates were calculated by subtracting from 100 the sum of the crude protein, fat, ash, and crude fibre values (per 100g). The following formula is used to calculate total carbohydrate content:

Carbohydrate (g/100g) =100- (moisture+ crude fibre + ash + crude protein + fat)

2.7 Determination of Energy
The samples' energy values were calculated using physiological fuel values of 4 Kcal per gram for protein, 9 Kcal per gram for fat and 4 Kcal per gram for carbohydrate.

Energy (Kcal/100g) = [(% protein x 4) + (% carbohydrates x 4) + (% fat x 9)]

3. Result and Discussion

Table 1: Proximate analyses results of maize varieties

Parameters (%)	Maize Varieties			
	VQPM-9	VLQPMH-59	PHM-3	PM-9
Moisture	3.60	3.40	3.46	4.00
Protein	7.41	5.63	13.81	8.25
Crude Fat	4.11	2.66	2.66	1.11
Ash	1.44	1.33	1.77	1.33
Crude Fibre	1.46	2.26	1.66	1.44
Carbohydrate	81.96	84.71	77.06	83.86
Energy (kcal/100g)	394.52	384.08	387.47	378.80

All the values are (Mean± SD) of three observations

Moisture content of the four maize varieties is presented in Table 1. Moisture content ranged between 4.00-3.40 percent. The significantly maximum value 4.00 percent for moisture content was observed in PM-9 variety developed by MPUAT, Udaipur. Moisture content of rest of the three varieties VQPM-9, PHM-3 and VLQPMH-59 (3.60%), (3.46%) and (3.40%) respectively were at par to each other. When compared to the work of Oluwalana, 2014 which reports a moisture content of maize between 9.85- 11.35 percent, it was observed that the maize varieties under study have a lower moisture content and thus can be stored for a longer time since higher moisture content reduces the shelf life.

Data in Table 1 represents total protein content. The highest value for protein content 13.81 percent was observed in variety PHM-3, followed by PM-9 and VQPM-9 which had a protein content of 8.25 percent and 7.41 percent respectively. The minimum value for protein content was observed in VLQPMH-59 with 5.63 percent protein content. The results of the present study were in line with those of Bibat *et al*., 2014 who reported the protein content of two QPM varieties to be 7.62 and 5.70 percent respectively. However, two of the maize varieties showed higher protein content than the reference.

The value for fat content varied significantly for the selected maize varieties, it ranged from 4.11- 1.11 percent (Table 1). Maximum value for fat content was found in VQPM-9 developed by ICAR-VPKAS, Almora with 4.11 percent fat content while the lowest fat content was observed in variety PM-9 with 1.11 percent fat content. Fat content of VLQPMH-59 and PHM-3 was at par with each other with 2.66 percent fat content. The results of the present study were in line with those of Panda *et al*., 2010 who found the fat content of normal maize and QPM to be 4.66 and 4.82% respectively.

The data for crude fibre is represented in Table 1. Maximum value of crude fibre content was observed in variety VLQPMH-59 with 2.26 percent followed by PHM-3, 1.66 percent. Crude fibre content of VQPM-9 and PM-9 was at par with each other with 1.46 and 1.44 percent fibre content respectively. The results indicate that the maize varieties under study have low crude fibre and correspond with the work of Abiose Sumbo & Victor, 2014 [1].

No significant difference for ash content was observed between the four selected varieties and it ranged from 1.77-1.33 percent (Table 1). All the varieties were at par to each other and the average ash content was found to be 1.47 percent. Ash content indicates the amount of minerals present in the sample and when compared to the work of Vandana *et al*., 2012 [13] who reported an ash content of 1.3 percent, the maize varieties under study have very low ash content and thus it can be concluded that they have very little mineral content.

Results reported a significant difference in carbohydrates content among the four selected maize varieties (Table 1). Carbohydrates content ranged between 84.71- 77.06 percent. The maximum value 84.71 percent for carbohydrates content was observed in the maize variety VLQPMH-59 which was at par with the carbohydrates content of PM-9 and VQPM-9 83.86 and 81.96 percent carbohydrates content respectively. Maize variety PHM-3 showed lowest carbohydrates content at 77.06 percent. The results of the present study correspond to those of David *et al*., 2016 [3] making them energy dense food option for human consumption.

Conclusion
Maize is one of the most widely consumed cereal crop around the world and also makes up the staple diet of a large population around the world. Maize is widely gown and consumed in India making it an important crop in Indian perspective. The results indicate that the varieties under study are an excellent source of protein, fat, carbohydrate and energy. However, the crude fibre and mineral content of the four maize varieties is apparently low. Thus, the four maize varieties are nutrient rich and can be recommended to be included in daily diet of Indian population.

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