J. Soils and Crops 33 (2) 376-381, December 2023
ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

THE CHANGES IN PROXIMATE COMPOSITION AND PHYSICO - CHEMICAL PARAMETERS OF MAIZE FLOUR BEFORE AND AFTER PROCESSING

Heleena Jati[1] and Saloni Chauhan[2]

ABSTRACT

An experiment to study the changes in proximate composition and physico-chemical parameters of Pioneer-3522 variety of maize flour before and after processing was carried out at the laboratory of Department of Food and Nutrition, College of Community Science, OUAT, Bhubaneswar, during August, 2022 to October, 2022. The quantity procured was 12 kg of QPM variety. The collected maize grains were cleaned by isolating damaged and unhealthy seeds and remaining foreign matter. The remaining maize grains were 10 kilogram and the lot was divided into four equal sets in triplicate for processing. Each replicate of maize grains was of 2.5 kg. For the study, out of four sets (in triplicate), one set was kept as such as control (in triplicate). The other three sets (each in triplicate) were kept for processing. The processing methods applied were boiling, roasting and alkali processing. The moisture content in alkali treated maize samples increased by 6.65 per cent whereas it was decreased in roasted and boiled samples by 35.28 per cent and 22.98 per cent respectively. In case of fat, there was increase in the percentage in all the three processed samples. The maximum increase in fat content was observed in alkali treated maize samples (14.90%) followed by roasted maize samples (13.47%) and boiled samples (4.30%). The maximum percentage loss in ash content was 19.53 per cent in case of alkali treated samples followed by 7.81 per cent in boiled and 6.25 per cent in roasted maize samples. The fibre content was observed to be in lowering trend in all the maize samples. The maximum reduction in fibre content was 7.20 per cent in boiled samples followed by 6.31 per cent in roasted samples and 1.80 per cent in alkali treated samples. The protein content in both roasted and alkali treated maize samples were decreased by 12.72 per cent and 0.46 per cent respectively whereas it was increased by 7.59 per cent in boiled maize samples. The carbohydrate content was increased in roasted and boiled maize samples and decreased in alkali treated maize samples. The carbohydrate content in roasted and boiled maize samples was increased by 6.24 and 2.02 per cent respectively whereas it was decreased in alkali treated maize samples by 1.17 per cent. After boiling, quality parameters like moisture, ash and fibre decreased whereas protein and carbohydrate increased in these maize grain flour. The similar trend was observed in flour of roasted maize grains except protein content which decreased in roasted maize grain flour samples. In case of alkali treatment, the change in moisture, fibre, protein and carbohydrate was not significant. Only the significant changes have been observed in the case of fat in positive direction and negative direction in ash.

(Key words: Maize, physico-chemical parameters, proximate composition, processing)

INTRODUCTION

Malnutrition or malnourishment is a condition that results from eating a diet in which nutrients are either not enough or are too much, such that the diet causes health problems. Malnutrition not only means when our body does not get enough nutrients in terms of carbohydrates, proteins, fats and vitamins but it may also occur due to lack of minerals as well. More than 80 per cent of the Indian population suffers from micronutrient deficiencies, contributing to compromised immunity (Chauhan *et al.*, 2021).

Micronutrient deficiencies are difficult to diagnose and consequently the problem may be termed "hidden hunger" in analogy to the term used in human nutrition. Deficiency of micronutrients during the last three decades has grown in both magnitude and extent because of increased use of high analysis fertilizers, use of high yielding crop varieties and increase in cropping intensity (Kaur and Kumar, 2023).

Maize (*Zea mays.* L*.)* is an important *kharif* crop. It belongs to poaceae family.It originated in Maxico. Maize is the third important cereal crop in the world after wheat and rice with respect to area under cultivation and production. India stands 4th in area under maize cultivation

1. Asstt. Professor, P.G. Deptt. of Home Science, Rama Devi Women's University, Vidya Vihar, Bhubaneswar-751022, Odisha, India
2. Ph.D. Scholar, Dept. of Food and Nutrition, College of Community Science, Punjab Agricultural University, Ludhiana-141004, Punjab, India

which is around 4% of the total world area and 2 per cent of total production (Kaur *et al.*, 2023).

Maize is a major cereal crop for both livestock feed and 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 nutricereal. Several million people, particularly in the developing countries, derive their protein and calorie requirements from maize (Prasanna *et al*., 2018).

Maize is a staple human food eaten by more than a billion people around the world in a variety of whole and processed form of products. Different processing methods result in changes to the nutritional profile of maize products, which can greatly affect the micronutrient intake of population dependent on this crop for a large proportion of their caloric needs. Mineral bioavailability can be improved by processing methods to reduce phytic acids, such as soaking, fermenting, cooking and nixtamalization. Loses of micronutrients during processing can be mitigated by changes in methods of processing, in addition to encouraging consumption of whole-grain maize products over degermed, refined products (Akinlolu *et al.*, 2014).

The composition of maize is 14.9 %-moisture, 11.1 %- protein, 3.6 %- fat, 2.7 %-fibre, 66.2 %-carbohydrates and 1.5 %- mineral matters. Out of the total mineral matter, 2.8 mg 100 g^{-1} is zinc, the majority of which is found in the germ. Maize also contains about 1g phytic acid 100 g^{-1} concentrated in germ, which forms insoluble complexes with zinc, reducing its bio-availability. The zinc can be made bio-available by reducing the phytic acid contents in maize. This can be achieved by processing as well as by adding phytase enzyme that helps to hydrolyze the phytate to lower inositol phosphates, resulting in improved zinc absorption (Kayode, 2018).

MATERIALS AND METHODS

The study was aimed towards processing of maize to prepare flour in order to find out the physico-chemical parameters and proximate composition. The selection and methods to achieve the goals have been grouped under different heads:

Selection of raw materials

Among the varieties, the most common normal maize being cultivated and popular among the maize consumers (Pioneer-3522) was selected for the study.

Procurement and processing of raw materials

Freshly harvested normal variety grains were procured from the farmer's field. For the study, the quantity of maize grains to be procured was 12 kg from normal variety. The grains were cleaned properly to remove dust and other unwanted materials.

The cleaned maize grains (10 kg) were divided into 4 lots for keeping one lot as 'control' and other 3 lots for processing by roasting, boiling and lime treatment. Further each lot was divided into 5 equal portions for the study. So, there were 20 portions from normal maize. Thus, the total portions were 40 for carrying out analytical work.

Analysis of maize grains for physico-chemical parameters

100 grain weight of maize was taken with the help of precision balance. Volume of grains was determined by Displacement method. The density of grains was calculated by mass/volume method. (Anonymous, 1983).

Determination of proximate composition

Moisture content was determined by hot air oven method. Ash content was estimated by the standard method of analysis. Crude-fibre content was estimated by standard method of analysis. Crude protein of the product was estimated by determining its total nitrogen content using Micro-Kjeldhal Method. The fat was determined by using the standard procedure and technique. The value obtained by subtracting the sum of the percentage of moisture, fat, ash, crude fibre and crude protein from 100 represents primarily the amount of total carbohydrate content. All followed by AOAC method (Anonymous, 2000).

Comparative efficacy of different parameters in maize

Comparative efficacy of the parameters was assessed by standard statistical procedures like Mean, Standard Deviation and Paired 't' test suggested by Panse and Sukhatme (1985).

Place of research

The research was conducted at the laboratory of Department of Food and Nutrition, College of Community Science, OUAT, Bhubaneswar.

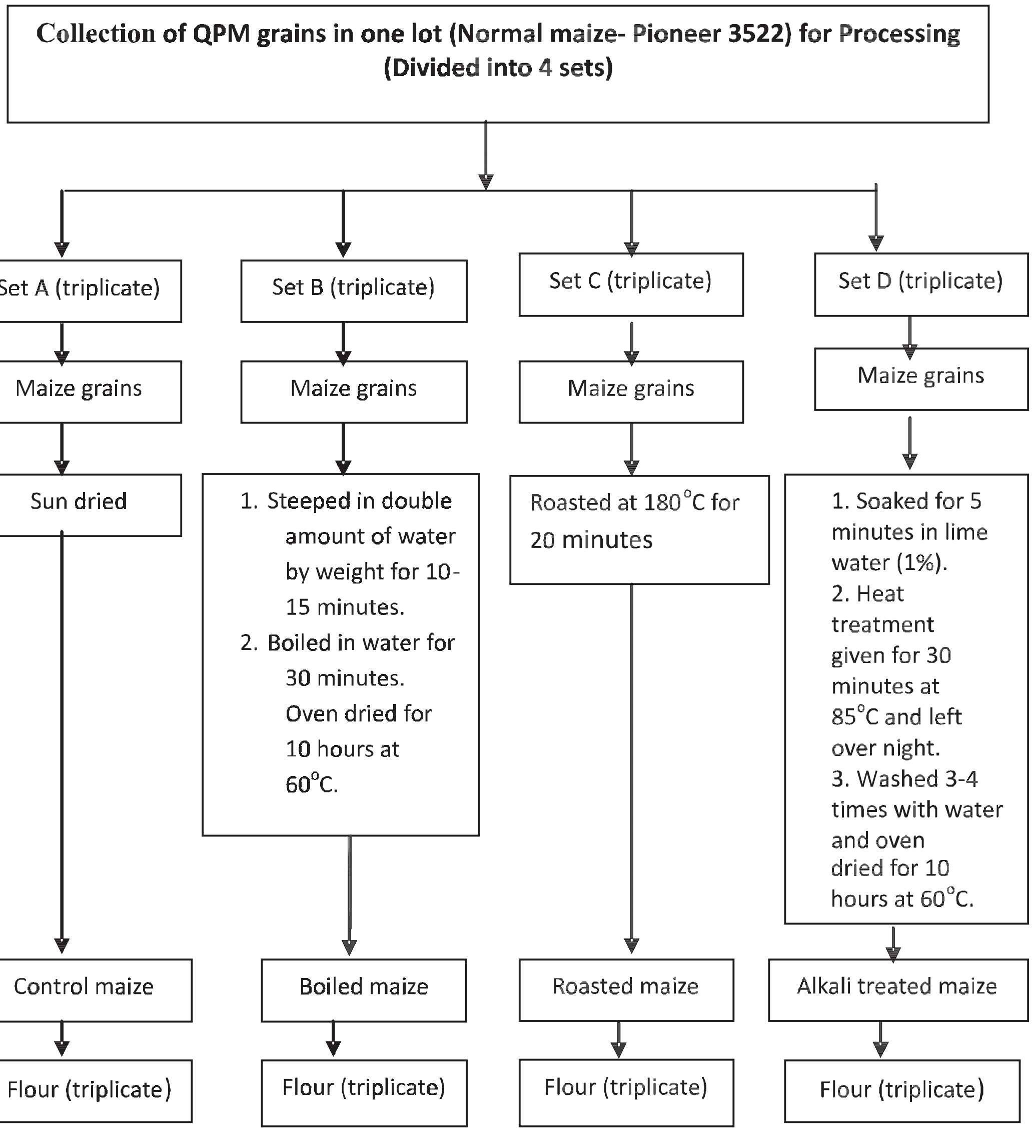

Figure 1. Preparation of maize grains and floursample

RESULTS AND DISCUSSION

Physico- chemical parameters of freshly harvested maize grains

To ascertain the physico-chemical quality of normal maize grains, weight, volume and density of the product were recorded to assess the physico- chemical characteristics. The data obtained has been presented in Table 1.

Table 1. Physico-chemical parameters of freshly harvested maize grains

Parameters	Observations
Weight (g)	27.71 ± 0.86
Volume (cc)	23
Density (g cc^{-1})	1.52 ± 0.01

Each value is the mean of six observations

The weight of freshly harvested normal maize grains was found to be 27.71 ± 0.86 g whereas volume of the grains was recorded to be 23 cc. The density was 1.52 ± 0.01 gcc^{-1}.

Proximate composition of freshly harvested normal maize flour before and after processing

The proximate composition of normal maize flour (control and processed) was determined. The data obtained on proximate composition in flour and quantitative changes in nutritional quality after application of different processing methods have been presented in Table 2 and 3.

The proximate composition of normal maize flour from freshly harvested maize grains before and after processing has been presented in Table 2. It is revealed from table that control maize flour sample contains 9.92 per cent moisture, 3.49 per cent fat, 1.28 per cent ash, 1.11 per cent fibre, 10.93 per cent protein and 73.27 per cent carbohydrate. In boiled maize flour sample, the per centage of moisture, fat, ash, fibre, protein and carbohydrate were

7.64, 3.64, 1.18, 1.03, 11.76 and 74.75 respectively. In case of roasted maize flour sample, the proximate composition was 6.42 per cent moisture, 3.96 per cent fat, 1.20 per cent ash, 1.04 per cent fibre, 9.54 per cent protein and 77.84 per cent carbohydrate. In alkali treated maize flour sample, the per centage of moisture, fat, ash, fibre, protein and carbohydrate were 10.58, 4.01, 1.03, 1.09, 10.88 and 72.41 respectively.

It can be observed from Table 2 that the percentage of moisture content in alkali treated sample was the highest (10.58%) followed by control maize sample (9.92%), boiled sample (7.64%) and roasted sample (6.42%). In case of fat, the maximum level was observed in alkali treated samples (4.01%) followed by roasted maize sample (3.96%), boiled sample (3.64%) and control sample (3.49%). The percentage of ash content in control sample was the highest (1.28%) followed by roasted maize sample (1.20%), boiled sample (1.18%) and alkali treated sample (1.03%). The percentage of fibre content in control sample was the highest (1.11%) followed by roasted maize sample (1.04%), boiled sample (1.03%) and alkali treated sample (1.09%). The percentage of protein content in boiled sample was the highest (11.76%) followed by control maize sample (10.93%), alkali treated sample (10.88%) and roasted sample (9.54%). In case of carbohydrate, the maximum amount was found to be in roasted samples (77.84%) followed by boiled maize sample (74.75%), control sample (73.27%) and alkali treated sample (72.41%).

The statistical analysis of the data obtained from determination of proximate composition of maize flour of control and processed maize grains clearly shows that the moisture content had significantly reduced in boiled maize flour ('t' value 19.995) and roasted maize flour ('t' value 7.793) at 1% level of probability. But there was no significant difference between the moisture content of flour obtained from control and alkali treated maize flour samples. If the difference among processed maize flour was observed, moisture content of alkali treated maize flour samples was significantly higher than roasted maize flour ('t' value-5.880) and boiled maize flour samples ('t' value -6.393) at 1% level of significance whereas the moisture content of alkali treated maize flour samples was significantly higher than roasted maize flour ('t' value 3.127) at 5% level of probability.

Mridula *et al.* (2008) observed that the hardness of pearl millet grain increased with increase in roasting temperature and time. The reason for the increase in hardness at increased temperature and time may be attributed to decrease in moisture content of the grain during the roasting process.

Fat content in all the processed maize flour samples increased significantly as compared to the flour of control samples. The significant difference at 1% level was obtained between flour of control and roasted maize flour samples ('t' value -37.342), control and alkali treated maize flour samples ('t' value -41.645), boiled and roasted maize flour samples ('t' value -7.773), and boiled and alkali treated maize flour samples ('t' value -11.539). But difference was significant at 1% level between the control maize flour samples and boiled maize flour samples ('t' value -4.934), and roasted maize flour samples and alkali treated maize flour samples ('t' value -5.046).

Just opposite to the fat content, the ash content in all the processed maize flour samples significantly reduced as compared to control maize flour samples. The ash content of control maize flour samples was significantly higher than boiled maize flour samples ('t' value 6.539), roasted maize flour samples ('t' value 5.674) and alkali treated maize flour samples ('t' value 12.775) at 1% level, 1% level and 1% level of probability respectively. Among processed maize flour samples, the ash content of boiled maize flour samples was significantly lower than roasted maize flour samples ('t' value -6.033) at 1% level and higher than that of alkali treated maize flour samples ('t' value 30.123) at 1% level of probability. As well as the ash content of roasted maize flour samples was significantly higher than that of alkali treated maize flour samples ('t' value 26.580) at 1% level of probability.

The fibre content was found to be lower after all processing methods. The decrease in fibre content was observed to be significant at 5% level in the samples of boiled maize flour ('t' value 3.052) and roasted maize flour samples ('t' value 2.983). The difference in fibre content of control maize flour samples and alkali treated maize flour samples was not significant. Among processed maize flour samples, the fibre content of boiled maize flour samples was lower than alkali treated maize flour samples ('t' value -2655) at 1% level of significance. As well the fibre content of roasted maize flour samples was significantly lower than that of alkali treated maize flour samples ('t' value -3.905) at 5% level of probability.

In case of protein content, significant changes have been observed in boiled maize flour samples ('t' value -3.421) and roasted maize flour samples ('t' value 5.274) as compared to control maize flour samples at 5% and 1% level of probability. The reduction in protein content of alkali treated maize samples as compared to control was not significant. Among processed maize flour samples, the protein content of boiled maize flour sample was significantly higher than alkali treated maize flour samples ('t' value 2.593) at 5% and roasted maize flour samples ('t' value 5.310) at 1% level of probability. The protein content of alkali treated maize flour samples was significantly higher than roasted maize flour samples ('t' value 6.203) at 1% level of probability.

The carbohydrate content in maize flour samples was found to be higher in case of boiled maize flour samples and roasted maize flour samples as compared to control maize flour samples. The carbohydrate content of control maize flour samples was significantly lower than boiled maize flour samples ('t' value -4.122) at 1% level and roasted maize flour samples ('t' value -16.626) at 1% level of probability. There was no significant difference in carbohydrate content of alkali treated maize flour samples as compared to control maize flour samples. A significant difference at 1% level has been observed in the carbohydrate content of roasted maize flour samples with boiled maize flour samples (‘t’ value -8.605) and with alkali treated maize flour samples (‘t’ value 8.276). The carbohydrate content of boiled maize flour samples was significantly lower than alkali treated maize flour samples (‘t’ value 5.239) at 1% level of probability.

Chung *et al*. (2011) revealed that physicochemical changes in corn were significantly affected by the roasting temperature and time. Thus, roasting temperature and time should be quantitatively controlled to obtain a desired quality of the roasted corn kernels. The change kinetics of physico-chemical property obtained in this study could be considered as an indicator for quality control in roasting processes dependence on the utilization of the roasted corn kernels.

Table 2. Proximate composition of normal maize flour from freshly harvested maize grains before and after processing

Maize grain Sample	Parameters (g 100 g^{-1})					
	Moisture (MeanS.D)	**Fat** (MeanS.D)	**Ash** (MeanS.D)	**Fibre** (MeanS.D)	**Protein** (MeanS.D)	**Carbohydrate** (MeanS.D)
Control (A)	9.92±0.294	3.49±0.021	1.28±0.039	1.11±0.060	10.93±0.631	73.27±0.423
Boiled (B)	7.64±0.387	3.64±0.087	1.18±0.009	1.03±0.044	11.76±0.571	74.75±0.927
Roasted (C)	6.42±1.328	3.96±0.011	1.20±0.007	1.04±0.023	9.54±0.572	77.84±0.910
Alkali treated (D)	10.58±1.157	4.01±0.016	1.03±0.017	1.09±0.028	10.88±0.343	72.41±0.075
‘t’ value among maize samples						
A×B	19.994**	(-) 4.934**	6.539**	3.052*	(-) 3.421*	(-) 4.122**
A×C	7.793**	(-) 37.342**	5.674**	2.983*	5.274**	(-) 16.626**
A×D	(-) 1.219^{NS}	(-) 41.645**	12.775**	0.885^{NS}	0.235^{NS}	1.595^{NS}
B×C	3.127*	(-) 7.773**	(-) 6.033**	(-) 0.185^{NS}	5.310**	(-) 8.605**
B×D	(-) 6.393**	(-) 11.539**	30.123**	(-) 2.655*	2.593*	5.239**
C×D	(-) 5.880**	(-) 5.046**	26.580**	(-) 3.905*	(-) 6.203**	8.276**

Each value is the mean of six observations

^{NS} Not significant

*Significant at 5% level of probability

**Significant at 1% level of probability

Changes in proximate composition of normal maize flour after processing as compared to control sample

The changes in proximate composition in maize flour after application of different processing methods as compared to control sample has been presented in Table 3.

Table 3. Changes in proximate composition of normal maize flour after processing as compared to control sample

Parameter (g 100 g^{-1})	Percentage change in maize grains		
	Boiled (B)	**Roasted (C)**	**Alkali treated (D)**
Moisture	22.98“!	35.28“!	6.65
Fat	4.30	13.46	14.90
Ash	7.81“!	6.25“!	19.53“!
Fibre	7.20“!	6.31“!	1.80“!
Protein	7.59	12.72“!	0.46“!
Carbohydrate	2.02	6.24	1.17“!

“!Indicates decreasing trend

The moisture content in alkali treated maize samples increased by 6.65 per cent whereas it was decreased in roasted and boiled samples by 35.28 per cent and 22.98 per cent respectively.In case of fat, there was increase in the percentage in all the three processed samples. The maximum increase in fat content was observed in alkali treated maize samples (14.90%) followed by roasted maize samples (13.47%) and boiled samples (4.30%).

Sefa-Dedeh *et al*. (2004) reported that nixtamalization of the maize resulted in increased pH, fat, moisture content, water absorption capacity and yellowing of products derived from the process. Alkaline cooking also improved the protein content of the nixtamalized maize products.

The maximum percentage loss in ash content was 19.53 per cent in case of alkali treated samples followed by

7.81 per cent in boiled and 6.25 per cent in roasted maize samples.The fibre content was observed to be in lowering trend in all the maize samples. The maximum reduction in fibre content was 7.20 per cent in boiled samples followed by 6.31 per cent in roasted samples and 1.80 per cent in alkali treated samples.The protein content in both roasted and alkali treated maize samples were decreased by 12.72 per cent and 0.46 per cent respectively whereas it was increased by 7.59 per cent in boiled maize samples.The carbohydrate content was increased in roasted and boiled maize samples and decreased in alkali treated maize samples. The carbohydrate content in roasted and boiled maize samples was increased by 6.24 and 2.02 per cent respectively whereas it was decreased in alkali treated maize samples by 1.17 per cent.

Ayatse *et al*. (1983) found that the Heat-processing (roasting, nixtamalisation, extrusion, boiling, baking or microwaving) under optimum conditions enhanced the colour, texture, flavour and nutritional qualities of food products.

It can be concluded from the Table 2 and 3 that after boiling, quality parameters like moisture, ash and fibre decreased whereas protein and carbohydrate increased in these maize grain flour. The similar trend has been observed in flour of roasted maize grains except protein content which was decreased in roasted maize grain flour samples. In case of alkali treatment, the change in moisture, fibre, protein and carbohydrate was not significant. Only the significant changes were observed in case of fat in positive direction and in case of ash in negative direction.

REFERENCES

Akinlolu, A.R., O. Ganiyu, A. A. Janet and A.T. Isaac, 2014.Effects of Different Processing Methods on the Micronutrient and Phytochemical Contents of Maize: From A to Z. Int. J. Appl. and Nat. Sci.**3**(5): 71-78.

Anonymous, 1983.National Institute of Nutrition.A manual of laboratory techniques. Indian Council of Medical Research, Hyderabad, pp. 23.

Anonymous,2000.Official methods of analysis.Association of official analytical chemists.15th Edition. Washington DC. USA. pp. 256.

Ayatse, J.O., O.U. Eka and E.T.Ifon, 1983.Chemical evaluation of the effect of roasting on the nutritive value of maize (*Zea mays* L.).J. Food Chem.**12**(6): 135-147.

Chauhan D., K. Kumar, N. Ahmed, T. P. Singh, P. Thakur, Q. H. Rizvi, A. N. Yadav and H. S. Dhaliwal,2021.Effect of Processing Treatments on the Nutritional, Anti-Nutritional and Bioactive Composition of Blue Maize (*Zea mays* L.). J. Curr. Res.Nutr. Food Sci.**10**(1): 123-134.

Chung, H. S., S. K. Chung and K. S. Youn, 2011. Effects of roasting temperature and time on bulk density, soluble solids, browning index and phenolic compounds of corn kernels. J.Food Pro.and Pres.**35**(3): 832-839.

Kaur, P. and R. Kumar, 2023.Role of integrated nutrient management on availability of macro and micro nutrients in soil and hybrid *kharif* maize (*Zea mays* L.) grains. J. Soils and Crops. **33**(1): 46-51.

Kaur, P., R. Kumar, V. Singh and N. S. Dhillon.2023.Impact of different land configurations with integrated nutrient management on quality and productivity of *kharif* maize (*Zea mays* L.). J. Soils and Crops. **33**(1): 63-67.

Kayode, A.P.P. 2018. Diversity, User's perception and food processing of sorghum: implications for dietary iron and zinc supply. Unpublished Ph.D thesis.Wageningen University, Wageningen, The Netherlands, pp 1-151.

Mridula, D., R.K. Goyaland M.R. Manikantan,2008.Effect of roasting on texture, colour and acceptability of pearl millet (*Pennisetum glaucum*) for making Sattu.Int. J. Agric. Res.**3**(6): 61-68.

Panse, V.G. and P.V. Sukhatme, 1985.Statistical methods for agricultural workers. Ind. Council of Agri. Res., New Delhi.

Prassanna, B.M., S. K Vasal, B. Kassahun and N.N.Singh, 2018.Effect of deterioration parameters on storage of Quality Protein Maize. J.Curr. Sci.**81**(10): 1308-1319.

Sefa- Dedeh, S., B. Cornelius, E. Sakyi-Dawson and E. O. Afoakwa, 2004. Effect of nixtamalization on the chemical and functional properties of maize.J. Food Chem.**36**: (8):317 – 324.

Rec. on 20.05.2023 & Acc. on 05.06.2023