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Effect Of Processing On The Physico-Chemical Parameters And Proximate Composition Of Maize Flour

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ABSRTACT

Nutrition is the bedrock of every individual's health, well-being, productivity and development. The nutritional well-being and health of all people are the vital pre requisites for the development of societies. Significant advances have been made in genetic enhancement of crop plants to increase their nutritional value. But malnutrition still remains a problem worldwide, particularly in developing countries. Micro- nutrient malnutrition is of great concern now-a-days. Micro nutrient deficiency is a major public threat. More than 80 % of the Indian population suffers from micronutrient deficiencies, contributing to compromised immunity. Worldwide, about, 1.1 billion people are zinc deficient due to inadequate dietary intakes. By 2050, India will be bearing the greatest burden of having 50 million zinc deficient people in the world. Some anti-nutritional factors like phytic acid hinders its bio-availability in the human body. So, the rationale of the study is to analyse the physico-chemical and proximate composition of maize before and after processing. Till now maize is not being taken as a staple food even after knowing its nutritional benefits. It contains 2.8 gm/ 100g Zinc and 1mg/ 100g phytic acid concentrated in the germ and by the application of various processing, the phytic acid content can be reduced and the zinc can become bio-available to the body. Therefore, this vital research is done in this field to enhance the bioavailability of zinc in order to reduce the serious symptoms of Zinc deficiency and malnutrition.

Keywords: Nutrition, malnutrition, micronutrient deficiency, processing

INRTODUCTION

Food is the primal of human needs. Nutritional well-being and health of individuals is necessary for the development of communities. Malnutrition is a serious problem world-wide. Micro- nutrient malnutrition is of great concern now-a-days. Micro nutrient deficiency is a major public threat. More than 80 % of the Indian population suffers from micronutrient deficiencies, contributing to compromised immunity.

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. The minerals present at levels less than 0.05 per cent in the human body are defined as micro minerals. The micro minerals also include trace elements. These trace elements are Chromium, Cobalt, Copper, Fluorine, Iodine, Iron, Manganese, Molybdenum, Selenium, and Zinc. One of such important Trace minerals is Zinc. More than 80 percent of the Indian population suffers from micronutrient deficiencies, contributing to compromised immunity.

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.

The clinical features of severe Zinc Deficiency in humans are growth retardation, delayed sexual and bone maturation, skin lesions, diarrhoea, alopecia, impaired appetite, increased susceptibility to infections mediated via defects in immune systems and the appearance of behavioural changes (Hambridge *et al*, 1987).

The world's population is dependent much on coarse, unrefined cereal grains, which contain high amount of phytic acid, a potent inhibitor of Zinc absorption, combined with recurrent infectious episodes, and is thought to be the basis of widespread Zinc deficiency disease in developing countries (Brown *et al*, 2004). Prevalence of zinc deficiency in developing countries is very common and 61% of the population is at an increased risk of low dietary zinc intake.

In cereals, the nutritional qualities are dictated mainly by their chemical compositions and the presence of anti-nutritional factors, such as phytic acid. phytates are present in whole grain cereals and legumes and in smaller amounts in other vegetables. They have a strong potential for binding divalent cations and their depressive effect on Zinc absorption has been demonstrated on humans (Sandstorm, 1989).

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*, 2001).

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 is Zinc, the majority of which is found in the germ. Maize also contains about 1g phytic acid/100g 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 hydrolyse the phytate to lower Inositol phosphates, resulting in improved zinc absorption.

The Molar Ratios between phytates and Zinc in diet is a useful indicator of the effect of Phytate in depressing Zinc absorption and Bio-availability. At Molar Ratios between the range 5 to 15, Zinc Bio-availability is medium, at molar ratios greater than 15, the Zinc bio-availability is low and at ratios below 5, the zinc-bioavailability is relatively good. Zinc absorption is typically less than 15 % in high Phytate meals (WHO, 1996).

The quality of protein in Quality Protein Maize variety has been improved due to balanced amino acid composition. ‘Quality Protein Maize’ (QPM), holds superior nutritional and biological value and is essentially interchangeable with normal maize in cultivation and kernel phenotype. The nutritional benefits of QPM for people who depend on maize for their energy and protein intake, and for other nutrients, are indeed quite significant. The other nutritional benefits of QPM include higher niacin availability due to a higher tryptophan and lower leucine content, higher calcium and carbohydrate and carotene utilization. Further, high quality protein maize can be transformed into edible products without deterioration of its quality or acceptability.

This is why maize has been chosen for this research work, so that the nutritional benefits of maize which are already known to us can be highlighted in terms of mineral nutrition, particularly Zinc and to evaluate practically the level of Zinc in different maize-based flours and to determine its Bio-availability, so that maize can again gain a plus point to be cultivated as a crop to meet the food needs first then to be grown as a commercial crop.

OBJECTIVES OF THE STUDY

1. To determine the physico-chemical parameters of freshly harvested normal maize.
2. To determine the proximate composition of freshly harvested normal maize before and after processing
3. To evaluate the proximate composition in maize before and after processing.
4. To study comparative efficacy of proximate composition in maize before and after processing.

HYPOTHESES

H_0 – Processing does not have any impact on the proximate composition in maize.

H_1 – Processing has some impact on the proximate composition in maize.

RESEARCH METHODOLOGY

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:

1. **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.

2. **Procurement and processing of raw materials**

   Freshly harvested normal variety grains was procured from the farmer's field. For the study, the quantity of maize grains to be procured was 10 kg from normal variety. The grains were cleaned properly to remove dust and other unwanted materials.

   The cleaned maize grains 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 will 20 portions from Normal maize. Thus, the total portions were 40 for carrying out analytical work.

3. **Analysis of maize grains for physico-chemical parameters**

   3.1 Weight: - 100 grain weight of maize and wheat was taken with the help of precision balance.

   3.2 Volume: - Volume of grains was determined by Displacement method.

   3.3 Density: - The density of grains was calculated by mass/volume method.

4. **Determination of proximate composition**

   4.1 Moisture content

   Moisture content was determined by hot air oven method (AOAC, 2000).

   4.2 Ash content

   Ash content was estimated by the standard method of analysis (AOAC, 2000).

   4.3 Crude- fibre content

   Crude-fibre content was estimated by standard method of analysis (AOAC, 2000).

   4.4 Crude protein content

   Crude protein of the product was estimated by determining its total nitrogen content using Micro-Kjeldhal Method (NIN, 1983).

   4.5 Crude fat content

   The fat was determined by using the standard procedure and technique followed by AOAC (2000).

4.6 Determination of total carbohydrate content

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.

5. 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.

6. Place of research

The research was conducted at the Government approved testing laboratories like OUAT, Bhubaneswar and Central Testing Laboratory, Mancheswar Industrial Estate, Bhubaneswar.

RESULT AND DISCUSSION

1. 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 and illustrated in Fig. 2.

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

Parameters	Observations
Weight (gm)	27.71 ± 0.86
Volume (cc)	23
Density (g/cc)	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 g/cc.

2. 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&3 and illustrated through Fig.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 percent moisture, 3.49 percent fat, 1.28 percent ash, 1.11 percent fibre, 10.93 percent protein and 73.27 percent carbohydrate. In boiled maize flour sample, the percentage 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 percent moisture, 3.96 percent fat, 1.20 percent ash, 1.04 percent fibre, 9.54 percent protein and 77.84 percent carbohydrate. In alkali treated maize flour sample, the percentage of moisture, fat, ash, fibre, protein and carbohydrate were 10.58, 4.01, 1.03, 1.09, 10.88 and 72.41 respectively.

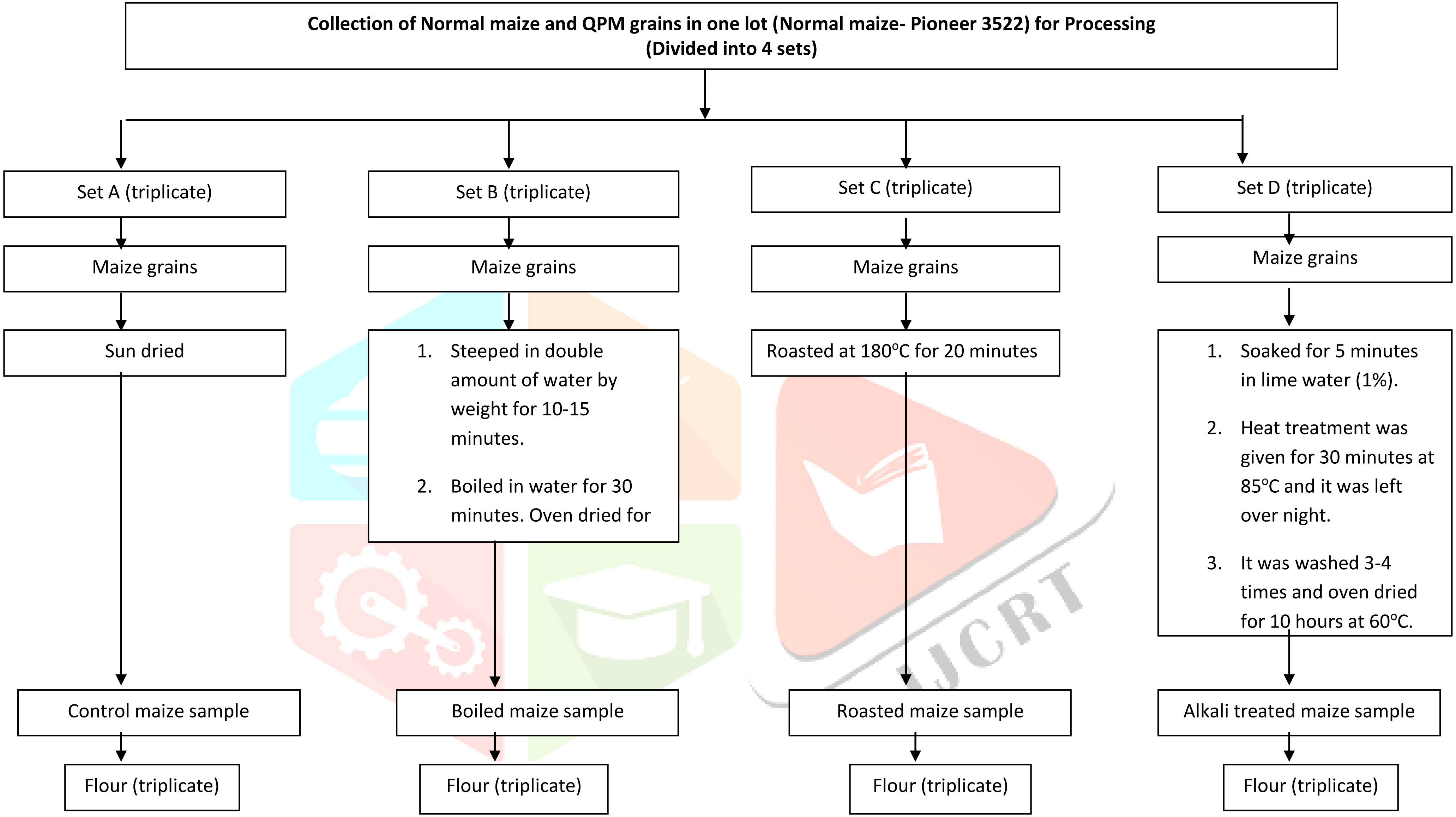

Fig.1. Preparation of maize grains and flour sample

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

Maize grain Sample	Parameters (g/100g)					
	Moisture (Mean±S.D)	**Fat** (Mean±S.D)	**Ash** (Mean±S.D)	**Fibre** (Mean±S.D)	**Protein** (Mean±S.D)	**Carbohydrate** (Mean±S.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

It can be observed in 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 is observed, moisture content of alkali treated maize flour samples is 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 is significantly higher than roasted maize flour (‘t’ value 3.127) at 5% level of probability.

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 0.1% 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.

1.1 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 and illustrated through Fig.3. The moisture content in alkali treated maize samples increased by 6.65 percent whereas it was decreased in roasted and boiled samples by 35.28 percent and 22.98 percent respectively.

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

Parameter (g/100g)	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

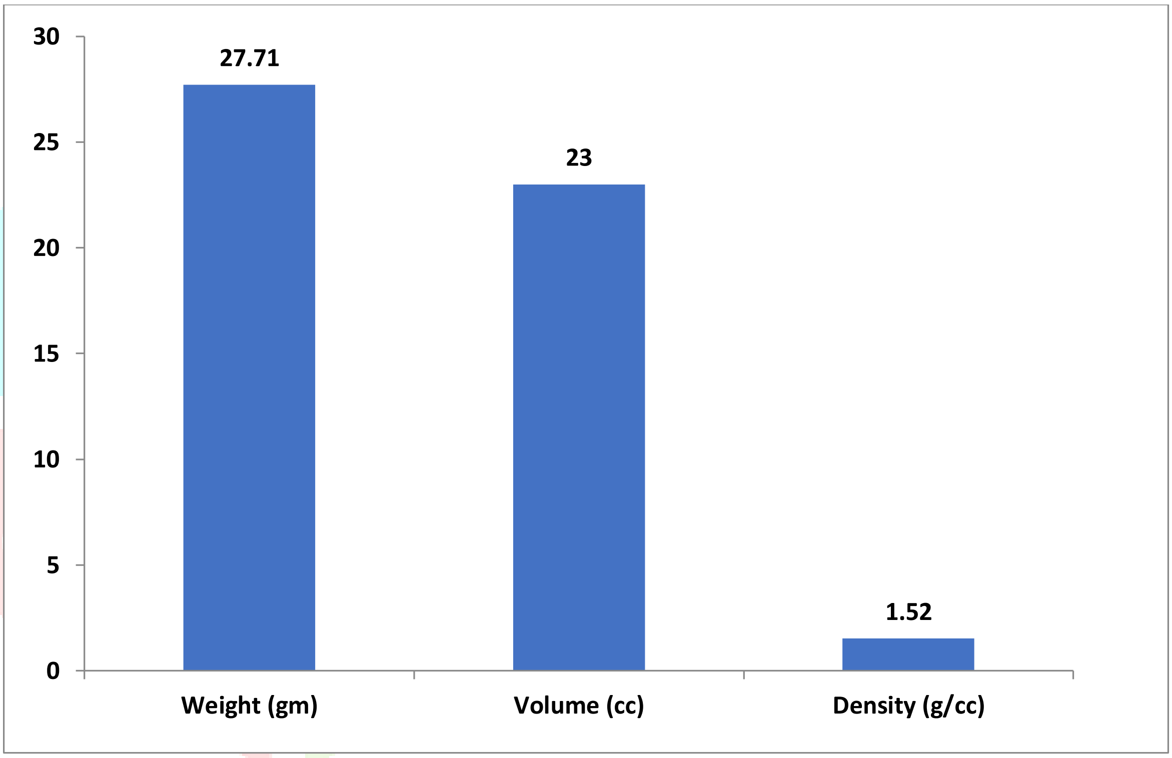

Fig. 2: Physico- chemical parameters of freshly harvested Normal maize grains.

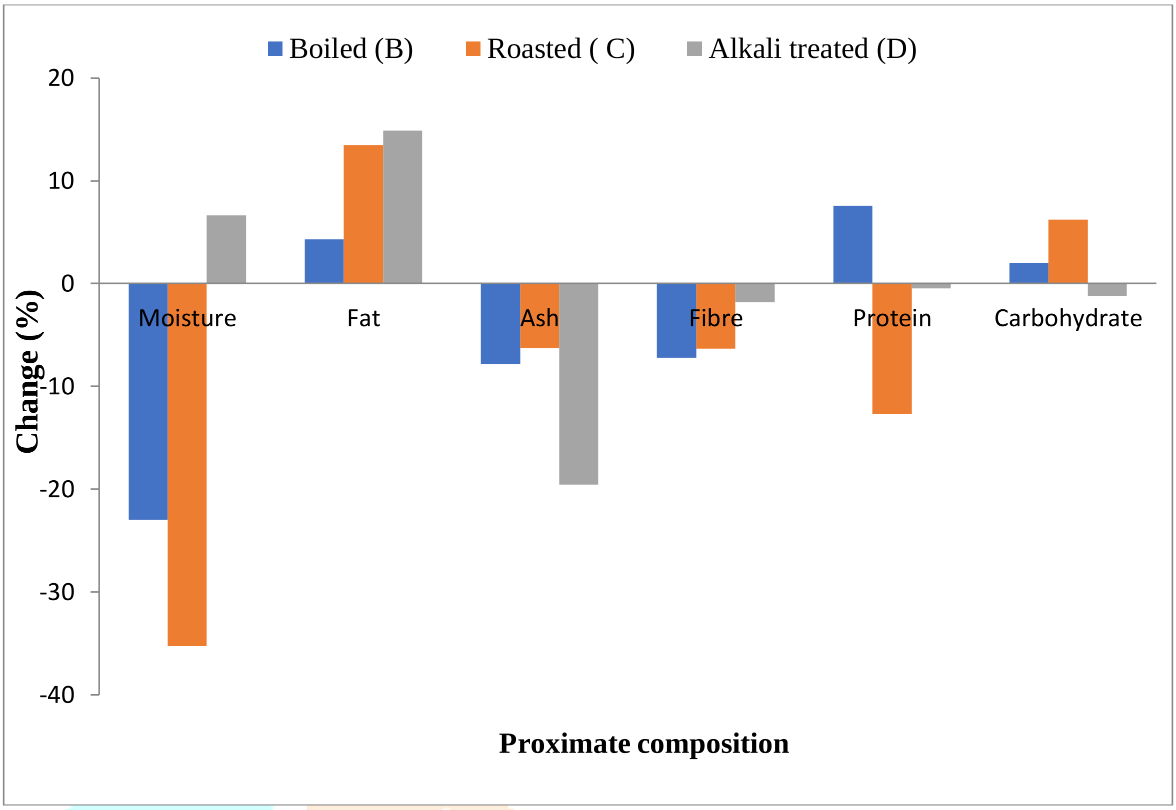

Fig.3: Changes in proximate composition in Normal maize flour after processing as compared to control sample.

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 percent in case of alkali treated samples followed by 7.81 percent in boiled and 6.25 percent 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 percent in boiled samples followed by 6.31 percent in roasted samples and 1.80 percent in alkali treated samples.

The protein content in both roasted and alkali treated maize samples were decreased by 12.72 percent and 0.46 percent respectively whereas it was increased by 7.59 percent 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 percent respectively whereas it was decreased in alkali treated maize samples by 1.17 percent.

It can be concluded from the Table 2 and 3 and Fig. 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 has 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 in case of ash in negative direction.

POSSIBLE OUTCOMES

1. Maize (Nutri-cereal) can be used as an alternative source of staple food instead of rice and wheat as it rich in carbohydrates, Protein and minerals.
2. Maize flour after various processing can be recommended for use in the Mid-day meal programme for combating macro and micro nutrient malnutrition, as the school going children are the most vulnerable sections of the society.
3. Maize has a Low- Glycaemic index, i.e., 52, and as it is rich in flavonoids and phenolic compounds which helps to reduce the risk of chronic diseases, like Diabetes.
4. This research output can lead to high cultivation of maize and development of innovative food products, that can create a great employability for the rural youth.

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