



## Organoleptic and Nutritional Evaluation of Value Added Noodles from Amaranth Seed Flour

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### Authors' contributions

This work was carried out in collaboration between both authors. Author PT designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author RM managed the analyses of the study. Both authors read and approved the final manuscript.

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### ABSTRACT

Pseudocereals are as good as the true cereals in many aspects of nutritional value. Either substituting or supplementing the staple cereals with pseudocereals and thereby improving the nutritive value of foods are under experimentation. Amaranth, a pseudocereal possess the usual characteristics of cereals such as bland taste, ease of cooking and also contain a substantial quality of cooking and fat as compared to most cereals. Amaranth contain good amount of fiber, energy and mineral than the conventional grains. Nevertheless, amaranth grain is still considered as a underutilized food crop and its consumed very few places. The usage of amaranth green, though very common in many parts of India. Development of nutritionally superior inexpensive food and acceptable to intended consumer is the biggest challenge of the present time. The present investigation was designed to develop high protein product by incorporation of amaranth flour. Amaranth flour was incorporate in the ratio of 20, 30, 40, 50, 60 and 70 per cent in the wheat flour. The higher score of overall acceptability was  $7.70 \pm 0.10$  for 50 per cent substitution of amaranth flour after control and the minimum as  $6.67 \pm 0.25$  for the 70 per cent amaranth flour noodles. Considering the results obtained and characteristics of flour used, the amaranth flour addition up to 30 per cent is evident to improve some nutritional properties and 50 per cent for sensory

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characteristic. Results also showed significant increase ( $P < 0.05$ ) in the protein (13.22 g) when compared with control (12.07 g). In this research it was analyzed that the different amount of amaranth flour plays an important role in noodles making by enhancing nutritional parameters and overall product quality. Resultant noodles can be used as a nutritious food with higher content of protein and other nutritious elements in an increased market of noodle product where quality protein is an issue.

**Keywords:** Nutritional quality; organoleptic characteristics; protein enrichments; noodles.

## 1. INTRODUCTION

*Amaranthus cruentus* grain contains sixty two per cent of starch and about fourteen to sixteen per cent of proteins, it is consumed as an ingredient in some foods such as puddings, soups, salad dressings. The nutrient content of amaranth grain has been comparable with common cereals as it's have better total protein, amino acids and minerals and vitamins than cereal grains [1]. Grain amaranth is a rich source of minerals such as calcium, iron, calcium, sodium, magnesium and zinc as well as vitamin riboflavin (0.19 to 0.23 mg/100 g of flour) ascorbic acid (4.50 mg/100 g), niacin (1.16 to 1.45 mg/100 g), and thiamine (0.07 to 0.1 mg/100 g) [2].

In today's era farmers are cultivating amaranth but they don't have knowledge about it's economic profit and nutritional value. Processing of amaranth is not much practiced by famers. This is the main reason of amaranth flour put in the category of underutilized grain.

The value addition by utilization of protein, iron and micronutrient rich foods in the diet is the most dependable strategy to overcome the nutritional gap and to help person to prevent from ravages of nutrient deficiencies. In this regard, by using under-utilized raw material to fortified food product, so by conversion of amaranth into amaranth incorporated food products is the way to reward the beneficial nutrients to the society.

Noodles renowned as staple food of Asian countries. Its utmost demand of today's era to find out the potential of noodle fortification and use it in public health intervention after improving its nutritional properties. With changing lifestyles, greater awareness about health and preference for instant food items have made instant noodles very popular and an item of mass consumption. Demand for ready to eat foods like extruded foods has risen considerably. Hence, development of noodles with value addition of amaranth can become a good choice to supply nutrients to population.

The current work has drawn attention towards encouragement of amaranth cultivation via creating a value-chain on production of amaranth-based value-added products which can help to improve food security and nutritional quality.

## 2. MATERIALS AND METHODS

### 2.1 Procurement and Processing of Raw Material

Wheat flour and amaranth purchased from local market. The cleaning of amaranth seed and wheat grain was performed manually to remove damaged seeds, dust particles, seed of other grains/crops and other impurities such as metals, glass, stones and weeds. Then both grains were milled in a mini grain mill at 60-200 mesh size to prepare flour in bulk and stored at ambient temperature in airtight container.

### 2.2 Preparation of Noodles

For noodle preparation, preliminary trials were done by replacing wheat flour with amaranth seed flour at different ratio as 20, 30, 40, 50, 60 and 70 per cent, semolina was used as a binding agent to prepared recipe. Method of preparation is briefed in Fig. 1.

**Preparation of raw noodles:** Amaranth seed flour and wheat flour were mixed in different ratio to prepare value added noodle (Table 1).

### 2.3 Sensory Evaluation of Prepared Cooked Noodles

The sensory evaluation of cooked noodles was carried out in order to determine the various aspects of sensory of the amaranth flour incorporated noodles (20%, 30%, 40%, 50%, 60% and 70% amaranth flour) compared to the control noodles (100% wheat flour) through a panel of ten semi-trained judges. Noodles was evaluated for different sensory attributes viz. color, flavour, texture, taste and overall

acceptability. Panelists were asked to indicate their preference on a 9-point Hedonic scale with degree of liking: 1 = extremely disliked to 9 = extremely liked.

## 2.4 Nutritional Analysis of Raw Materials

Physicochemical (moisture content and ash value) and chemical composition (carbohydrate, protein, fiber and fat) of raw materials were evaluated according to standard

Internationally Approved Methods (2000) described by Association of Analytical Chemists (AOAC) for the assessment of quality of raw materials. Moisture content was evaluated as per AOAC [3] method; ash value was evaluated as per AOAC- 923.03 method; protein content was determined as per (IS:7219:1973) Kjeldhal method, final protein content was obtained by using the conversion factor of 6.25 and fat content was determined by NIN [4].

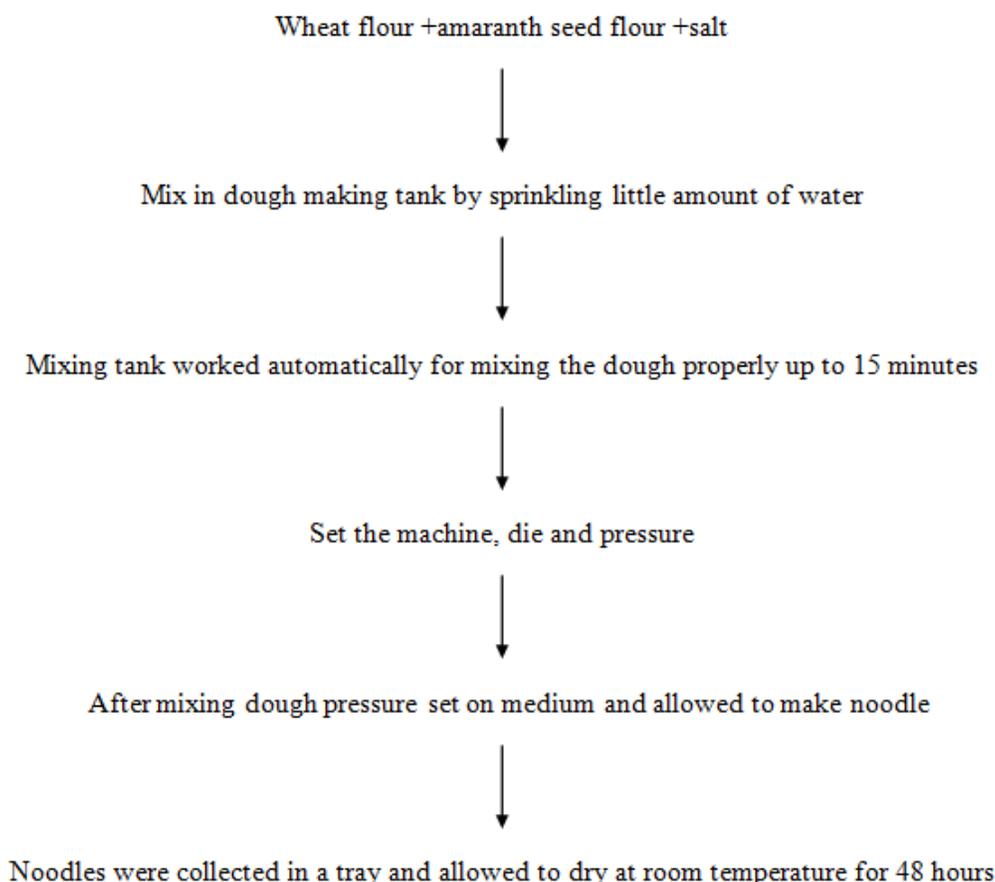


Fig. 1. Flow chart for preparation of noodle

Table 1. Standardized recipe of noodles (1kg) by using amaranth seed

| Ingredients             | Control | T <sub>1</sub><br>(20%) | T <sub>2</sub><br>(30%) | T <sub>3</sub><br>(40%) | T <sub>4</sub><br>(50%) | T <sub>5</sub><br>(60%) | T <sub>6</sub><br>(70%) |
|-------------------------|---------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Wheat flour (g)         | 1000    | 800                     | 700                     | 600                     | 500                     | 400                     | 300                     |
| Amaranth seed flour (g) | -       | 200                     | 300                     | 400                     | 500                     | 600                     | 700                     |
| Semolina (g)            | 250     | 250                     | 250                     | 250                     | 250                     | 250                     | 250                     |
| Salt (g)                | 15      | 15                      | 15                      | 15                      | 15                      | 15                      | 15                      |
| Water (ml)              | 600     | 750                     | 800                     | 850                     | 900                     | 950                     | 1000                    |

### 2.5 Statistical Analysis of Data

The data were statistically analyzed as Frequency percentage, Mean Analysis of Variance (ANOVA) was applied to nutritional constituents of amaranth grain and developed products, functional properties of flour, mineral composition and storage quality of formulated products.

Formulas used for analysis of data are given below (Gupta, 2004)

**Percentage:** Sample comparison was made on the basis of percentage. Percentage is the frequency of particular cell multiplied by 100, divided by total number of respondents in the particular category.

$$\text{Formula: } P = n/N \times 100$$

Where, "n" denotes frequency of particular cell.

'N' denotes total number of respondents in particular category

'P' denotes the percentage

Mean ( $\bar{X}$ )

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n x_i$$

where,

x = observation  
n = number of observation  
i = 1,2,3.....

Standard deviation (SD)

$$SD(\sigma) = \sqrt{\frac{\sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i\right)^2}{n - 1}}$$

### 2.6 ANOVA One Way Classification

Data obtained from the organoleptic evaluation, functional parameter, anti-nutritional analysis, nutrient analysis and mineral analysis were

subjected to analysis of variance techniques (one way classification) and critical difference was calculated to calculate the significant difference between treatments (Table 2).

**Sum of square due to treatment (SST)**

$$SST = \frac{\sum_{i=1}^k \left( \sum_{j=1}^r X_{ij} \right)^2}{r} - \frac{\sum_{i=1}^k \left( \sum_{j=1}^r X_{ij} \right)^2}{rk}$$

**Total sum of square (TSS):**

$$TSS = \frac{\sum_{i=1}^k \sum_{j=1}^r X_{ij}^2 - \sum_{i=1}^k \left( \sum_{j=1}^r X_{ij} \right)^2}{rk}$$

**Sum of square due to error (SSE):**

$$SSE = TSS - SST$$

**Critical difference (CD):** The critical difference was calculated for finding out the significant difference between the corresponding two mean values:

$$CD = \text{Sem.} \sqrt{2} \cdot t_{\text{tab}} \text{ at 5\% and 1\% LS and error d.f.}$$

**Standard error for means:**

$$\text{Sem} = \sqrt{\frac{\text{EMS}}{r}}$$

Where,

EMS = Error mean square  
X<sub>ij</sub> = value of i<sup>th</sup> treatment in j<sup>th</sup> replications  
r = Number of replications  
k = Treatments

**Table 2. Anova for one way classified data**

| Source of Variation | Degree of Freedom (d.f.) | Sum of Squares | Mean Squares               | Variance Ratio (F)       |
|---------------------|--------------------------|----------------|----------------------------|--------------------------|
| Treatment           | k-1                      | SST            | $MST = \frac{SST}{k - 1}$  | $F = \frac{MST}{MSE}$    |
| Error               | rk-k                     | SSE            | $MSE = \frac{SSE}{rk - k}$ | $\sim F [(k-1), (rk-k)]$ |
| Total               | rk-1                     | TSS            | -                          |                          |

**ANOVA two way classifications (Factorial design):**

It was applied to assess the effect of storage on sensory characteristics, chemical constituents and colour values of developed flour and products.

In two way classification, the analysis of variance is studied in following three parts:

- i. Sum of Squares Between Columns (SSC)
- ii. Sum of Squares Between Rows (SSR)
- iii. Residual Variation (SSE)

Total Sum of Squares = Sum of Squares between Columns + Sum of Squares Between Rows + Residual Variation or TSS = SSC + SSR + SSE.

Following steps were followed to calculate Variance Ratio (F) in the case of Two way classification

- (i) Coding method was used to simplify the calculations.
- (ii) Calculation of Correlation Factor

$$\text{Correlation Factor (c.f.)} = \frac{r^2}{N}$$

- (iii) **Total Sum of Squares (TSS):** it is obtained by subtracting correction factor from the total squared values of the sample, i.e.

$$\text{TSS} = \sum X_2^2 + \sum X_3^2 + \sum X_4^2 + \dots - \frac{r^2}{N}$$

- (iv) **Sum of Squares between Columns (SSC):** The total of each column was squared and divided by the number of items in respective columns. The correction factors subtracted from the total of thus arrived values and SSC is obtained:

$$\text{SSC} = \sum \left\{ \frac{(\sum X_c)^2}{n_c} \right\} - \frac{r^2}{N}$$

- (viii) **ANOVA Table:** In a two way classification the analysis of variance table is prepared in the following form:

Where  $\sum X_c^2$  = Total of squared values in each columns

$n_c$  = Number of items in each column.

- (v) **Sum of Squares between Rows (SSR):** The total of the sample values in each row is squared and divided by the number of items in the respective row. From the total of the values thus arrived correction factor is deducted and remaining is known as sum of squares between rows or SSR.

$$\text{SSC} = \sum \left\{ \frac{(\sum X_R)^2}{n_R} \right\} - \frac{r^2}{N}$$

Where

$\sum X_R$  = Total of squared values in each columns

$N_R$  = Number of items in each column.

- (vi) **Sum of Squares of the Residual (SSE):** The sum of the squares of the residual is obtained by deducting the sum of squares between columns and sum of squares between rows from the total sum of squares:

$$\text{SSE} = \text{TSS} - (\text{SSC} + \text{SSR})$$

- (vii) **Number of Degrees of Freedom:** It is calculated as follows:

No. of degrees of freedom between columns = (c-1)  
 No. of degrees of freedom between rows = (r-1)  
 No. of degrees of freedom for residual = (c-1) (r-1)  
 Total No. of degrees of freedom = N-1 or Cr-1

Where,

'r' refers to number of rows  
 'c' refers to number of columns  
 'N' refers to total number of items in the samples.

**Table 3. ANOVA Table (Two-way classification)**

| Source of Variance | Sum of Squares | Degrees of Freedom | Mean Sum of Squares (MSS) | F Ratio               |
|--------------------|----------------|--------------------|---------------------------|-----------------------|
| Between Columns    | SSC            | c-1                | SSC ÷ (c-1) =MSC          | $F = \frac{MSC}{MSE}$ |
| Between Rows       | SSR            | r-1                | SSC ÷ (r-1) =MSR          | $F = \frac{MSR}{MSE}$ |
| Residual           | SSE            | (c-1) (r-1)        | SSC ÷ (c-1) x (r-1) =MSE  |                       |
| Total              | TSS            | N-1 or Cr-1        |                           |                       |

### 3. RESULTS AND DISCUSSION

#### 3.1 Sensory Evaluation of Prepared Cooked Noodles

Sensory evaluation was carried out as per nine-point hedonic scale by a 10 member panel and results of the evaluation are presented in Table 4. Among the fortified treatments (Control, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>). Treatment T<sub>4</sub> (50%) had highest overall acceptability as compared to other fortified samples. This shows that after 50 per cent amaranth flour incorporation the acceptability is decreasing. So, the 50 percent sample was finalized for nutritional analysis.

Table 4 shows the result of sensory scores of noodles incorporated with different levels of amaranth seed flour. It's apparent from the Table 2 that the overall acceptability mean score of value-added amaranth seed flour noodle ranged from 6.67±0.25 to 7.70±0.10. This data showed that the noodles were found to fall under the category of 'Liked slightly' to 'like moderately'. Perusal of the data in Table 2 reveals that maximum scores for all sensory attributes

i.e. 7.97±0.06, 8.00±0.10, 8.10±0.10, 7.97±0.25, 8.03±0.06 and 8.07±0.06 for color, flavour, taste, texture, appearance and overall acceptability respectively were obtained by control as compared to all other treatments. Among the all treatments, T<sub>4</sub> (50% amaranth seed flour) showed that the highest score for all the sensory attributes except color. Score obtained were 7.37±0.47 (colour), 7.51±0.15 (flavour), 7.30±1.01 (taste), 7.57±0.31 (texture), 7.70±0.17 (appearance) and 7.70±0.10 (overall acceptability) than the noodle prepared with 20, 30, 40, 60 and 70 per cent level of amaranth seed flour. With increase in the incorporation level (60% and 70%) of amaranth seed flour, there was general decrease in all sensory attributes. Treatment T<sub>4</sub> (50%) was observed to score the highest for all sensory characteristics among all treatments. Therefore, T<sub>4</sub> was selected for the further study.

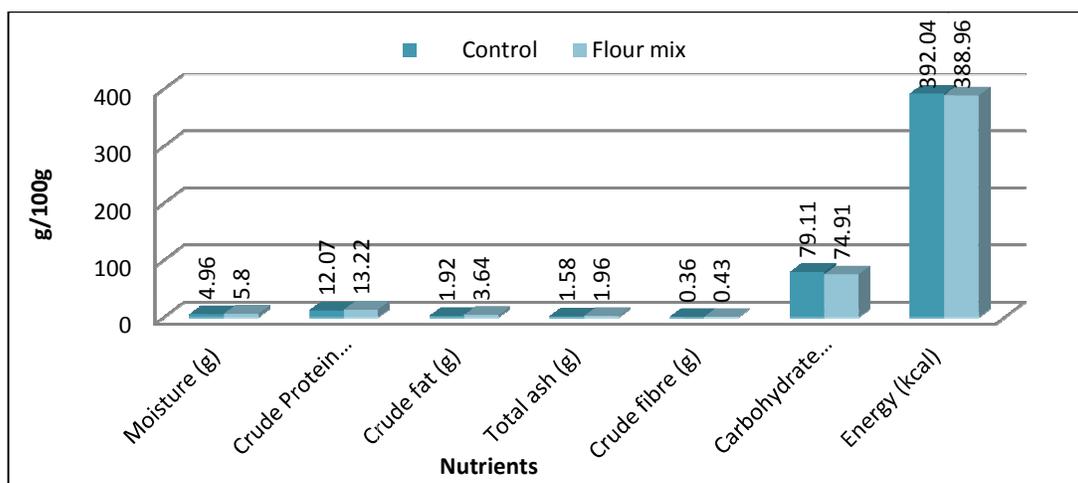
Results are in conformity with the findings of Bhatt *et al.* [5], who developed standardize process of fortified pasta by substituting normal pasta ingredient with amaranth flour to improve the quality of pasta.

**Table 4. Mean±SD scores of sensory evaluation of noodles prepared by using amaranth seed flour**

| S. No. | Products       | Sensory attributes |           |           |           |            | Overall acceptability |
|--------|----------------|--------------------|-----------|-----------|-----------|------------|-----------------------|
|        |                | Colour             | Flavour   | Taste     | Texture   | Appearance |                       |
| 1.     | Control        | 7.97±0.06          | 8.00±0.10 | 8.10±0.10 | 7.97±0.25 | 8.03±0.06  | 8.07±0.06             |
| 2.     | T <sub>1</sub> | 7.37±0.06          | 7.40±0.00 | 7.27±0.32 | 7.53±0.12 | 7.57±0.15  | 7.37±0.06             |
| 3.     | T <sub>2</sub> | 7.43±0.06          | 7.47±0.06 | 7.30±0.53 | 7.57±0.15 | 7.57±0.15  | 7.47±0.06             |
| 4.     | T <sub>3</sub> | 7.47±0.12          | 7.50±0.10 | 7.27±0.67 | 7.50±0.20 | 7.63±0.15  | 7.60±0.10             |
| 5.     | T <sub>4</sub> | 7.37±0.47          | 7.51±0.15 | 7.30±1.01 | 7.57±0.31 | 7.70±0.17  | 7.70±0.10             |
| 6.     | T <sub>5</sub> | 6.47±0.06          | 6.67±0.25 | 6.57±0.76 | 6.93±0.12 | 7.27±0.15  | 7.00±0.30             |
| 7.     | T <sub>6</sub> | 6.17±0.06          | 6.43±0.15 | 6.33±0.67 | 6.70±0.10 | 6.87±0.15  | 6.67±0.25             |
|        | GM             | 7.12±0.62          | 7.28±0.52 | 7.14±0.76 | 7.38±0.43 | 7.52±0.37  | 7.41±0.46             |
|        | SE             | 0.11               | 0.08      | 0.37      | 0.11      | 0.08       | 0.09                  |
|        | CD 5%          | 0.33*              | 0.24*     | 1.12*     | 0.34*     | 0.26*      | 0.28*                 |

**Table 5. Proximate composition of physicochemical and chemical composition of raw materials**

| S.No. | Nutrients         | Control      | Flour mix   | SE   | t-value   |
|-------|-------------------|--------------|-------------|------|-----------|
| 1.    | Moisture (g)      | 4.96±0.02    | 5.80±0.02   | 0.01 | 51.439**  |
| 2.    | Crude Protein (g) | 12.07±0.03   | 13.22±0.02  | 0.02 | 50.469**  |
| 3.    | Crude fat (g)     | 1.91±0.01    | 3.64±0.02   | 0.01 | 118.837** |
| 4.    | Total ash (g)     | 1.58±0.02    | 1.96±0.01   | 0.01 | 8.030**   |
| 5.    | Crude fibre (g)   | 0.36±0.02    | 0.43±0.02   | 0.01 | 4.131*    |
| 6.    | Carbohydrate (g)  | 79.11±0.05   | 74.90±0.07  | 0.05 | 60.361**  |
| 7.    | Energy (kcal)     | 392.04± 0.09 | 388.96±0.10 | 0.08 | 38.427**  |



**Fig. 2. Proximate composition of developed raw material**

### 3.2 Evaluation of Physicochemical and Chemical Composition of Raw Materials

The nutritional composition provides basic information about the component and quality of the products. Results of proximate of amaranth seed based formulated product have been presented below:

The data on various nutrients determined from control and experiment are given in Table 5 and Fig. 1. Among the nutrients protein, fat, total minerals, fiber, calcium, phosphorus, iron, were found to be higher in experimental than control sample. The noteworthy increase was recorded in moisture (from 4.96 to 5.80 g), crude protein (from 12.07 to 13.22 g), crude fat (from 1.91 to 3.64 g), total ash (from 1.58 to 1.96 g) and crude fiber (from 0.36 to 0.43 g). Further it was noticed that energy and carbohydrate contents were found to be lower in experimental sample. It might be due to the fact that experimental sample was dense in other nutrient content.

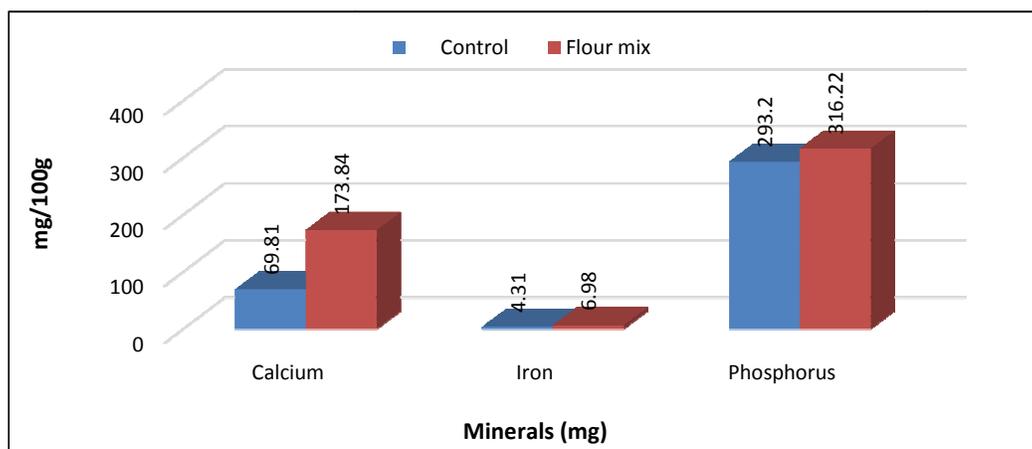
Statistically significant difference was noted in the fiber at 1 per cent level and in the moisture, crude fat, crude protein, total ash content and crude fiber value at 5 per cent level.

Bhatt *et al.* [5] analyzed physico chemical composition of fortified pasta and flour analysis revealed that amaranth flour had better nutrients than semolina and wheat flour. Due to which significant increase in protein by addition of amaranth flour was observed. Pasta prepared from amaranth flour contained higher level of protein 9.33, 10.30 and 11.57 g and may offer the inherent benefits of amaranth flour to the consumer.

Table 6 depicted that the amaranth seed flour incorporated flour mix recorded higher calcium (173.84 mg/100 gm) than control sample (69.80 mg/100 gm). The phosphorus and iron content of experimental instant mix was 316.22 mg and 6.98 mg per 100 gm, whereas the control sample contained 293.20 mg of phosphorus and 4.30 mg of iron per 100 gm.

**Table 6. Mineral content of developed raw material (per 100g on dry weight basis)**

| S.No. | Minerals (mg) | Control     | Flour mix    | SE   | t-value    |
|-------|---------------|-------------|--------------|------|------------|
| 1.    | Calcium       | 69.80± 0.04 | 173.84±0.03  | 0.03 | 3308.333** |
| 2.    | Iron          | 4.30±0.03   | 6.98±0.01    | 0.02 | 131.848**  |
| 3.    | Phosphorus    | 293.20±0.03 | 316.22± 0.02 | 0.02 | 1007.359** |



**Fig. 3. Mineral content of raw material**

Results are in accordance with Shimelis *et al.* (2012) which states that protein, fat, ash, iron, zinc, phosphorous and calcium contents in the blends increased significantly with an increase in amaranth substitution with wheat flour. They stated that the substitution of wheat flour with amaranth one can contribute to improvement of food security and production of various gluten-free value added products.

Bala [6] prepared noodles with incorporation of amaranthus leaves powder (ALP), amaranthus flour (AF) and amaranthus protein concentrate (APC) and reported that amaranthus seeds had higher fat (5.02%), protein (15.6%), fiber (3.5%) and minerals as compared to wheat, which contributed to the better nutritional profile of developed noodles.

#### 4. CONCLUSION

Amaranth's seeds are becoming to be more included in the diet of population that suffer bad nutrition/poor diet because of poverty or because they have diseases as anorexia among others where protein must be fulfilled because it is a pseudo cereal that counts with several nutrients in a balanced proportion including dietary fiber, essential amino acids, relevant lipids, antioxidants and high amounts of calcium, manganese and iron.

Study concluded that wholegrain wheat noodles supplemented with 20 per cent, 30 per cent, 40 per cent, 50 per cent, 60 per cent and 70 per cent Amaranth seed flour demonstrated good quality. Proximate evaluation indicates that incorporation of amaranth seed flour increased the protein, fiber and sugar content of the noodles keeping the fat at optimum level. Fortified noodles were highly acceptable with respect to sensory attributes.

Resultant noodles can be used as healthy and nutritious food with higher content of protein and other micronutrients in an increasing market of noodles products where quality protein is an issue.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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