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Study on nutritional and organoleptic characteristics of value-added pasta from amaranth flour

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Abstract
Amaranth (Family Amaranthaceae) is a pseudo-cereal content high protein (12.5-19%) with a rich amount of nutritionally critical amino acids such as methionine and lysine (0.73 -0.84%) and amaranth also rich in vitamin and minerals such as riboflavin, niacin, ascorbic acid, calcium, and magnesium compared to other grains. The purpose of the present study was to develop value added pasta with the replacement of refined wheat flour by amaranth flour (20%, 40%, 60%, 80% and 100%) and addition of semolina with the replacement of composite flour of refined wheat flour and amaranth flour (10% and 20%). 1% guar gum powder, Salt (1.5%) and Oil (2%) were added in all blends other than control. On the basis of organoleptic evaluation, value-added pasta when incorporated with 60% amaranth flour and 10% semolina (T5) was more acceptable in sensory parameters on 9-point hedonic scale and nutritionally superior in protein as compare to control. Nutritional composition of value-added pasta varied significantly ($p < 0.05$). The result showed that moisture content 8.07 to 9%, ash 2.04 to 3.62%, protein 10.81 to 15.87%, fat 0.77 to 4.14%, crude fibre 0.91 to 6.39%, carbohydrates 68.30 to 77.39%, and energy value 359.68 to 373.94 Kcal/100g, respectively. Amaranth's seeds are increasingly being incorporated into the diets of those who have poor diets or low nutrition as a result of poverty or other factors.

Keywords: Pasta, amaranth flour, organoleptic evaluation, nutritional characteristics

Introduction
Cereal based pasta is mainly used worldwide because of rich in nutrition, longer storage period, easy to handle and high palatability. It is considered as an adequate medium for food supplementation with minerals, proteins and many other valuable healthy components (Borneo and Aguirre 2008) [8]. Traditional pasta is made from semolina and refined wheat flour, has low contents of protein, minerals, vitamins and dietary fiber. Traditional pasta proteins contain low amounts of lysine, methionine and threonine (Kies and Fox 1970 [14]; Heger and Frydrych 1987) [12]. Therefore, with an aim to improve the nutritional quality and to add variety to the culinary experience, various nontraditional ingredients such as soybean (Glycine max) flour, flaxseed (*Linum usitatissimum*) flour (Marconi and Carcea 2001 [15]; Sinha *et al*., 2004) [22], and amaranth (*Amaranthus cruentus*) flour (Jatav *et al.*, 2016 [13]; Tripathi and Mogra, 2020) [26] have been added to pasta.

Amaranth (A. caudatus) family: Amaranthaceae is an annual plant whose name derived from the Greek. It's popularly referred to as chaulai, in Hindi which is incredibly nutritive and highly suitable crop for kitchen gardening and commercial cultivation (Shinde and Raghuvanshi, 2015) [19]. According to Solanki *et al.*, (2021) [23], on the states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Assam, Meghalaya, Nagaland, Arunachal Pradesh, Tripura, Jharkhand, Chhattisgarh, Orissa, Tamil Nadu, Karnataka, and Kerala, amaranth is cultivated in both plains and hills. It is grown both as pure also mixed crop throughout the Rabi and kharif harvest seasons. The proteins have a high sulphur containing essential amino acids (Lysine, Methionine and Cysteine), which makes it superior than cereals crops. It's worth lies in its edible leaves and sensitive stem, high biocompatibility, nutritional value, antioxidants, mineral contents and low cost of production and sale than cereal crops (FAO 2020) [10]. Amaranth was reemerging as one of the health care crops in several nations, including India, due to its nutritional properties, which included its higher protein, lysine, fibre, and iron content as well as its low level of saturated fats and gluten free of grain. Idowu *et al*., (2013) [3] studied the nutritive value of amaranth seeds (100g) consists of energy 319 kcal, protein 14.7g, fat 1.9 g, carbohydrate 60.7g, calcium 510mg, phosphorus 397mg,

iron 11.0mg, minerals 3.1g, moisture 10.0g, crude fiber 9.6g. Grain amaranth could be a rich source of minerals like calcium, iron, calcium, sodium, magnesium and zinc still as vitamin riboflavin (0.19 to 0.23 mg/100 g of flour) vitamin C (4.50 mg/100 g), niacin (1.16 to 1.45 mg/100 g), and thiamine (0.07 to 0.1 mg/100 g), (Gopalan *et al.*, 2007) [11].

Guar-gum may be a novel agrochemical processed from endosperm of leguminous plant. It's largely employed in the shape of gum powder as an additive in food, Industrial applications of gum are possible due to its ability to make hydrogen bonding with water molecule. Thus, it's chiefly used as thickener and stabilizer. It's also beneficial within the control of the many health problems like diabetes, bowel movements, cardiovascular disease and carcinoma. Guar-gum is used for increasing the dough yield in baked goods. It reduces unparalleled moisture preservation to the dough and retards fat penetration in baked food, which provides greater resiliency and improves texture and shelf life. (Mudgil D *et al.*, 2014) [17].

Becker *et al.*, (1981) studied nutritional aspect concerning the food value of grain amaranth and postulated that the identification of the limiting amino acids like methionine and lysine (0.73 -0.84%) of the protein component. Amaranth encompasses a significant amount of soluble and insoluble fiber content and a high protein concentration between 12.5% -19%. It might be very valuable for combating under-nutrition and malnutrition in India. Amaranth features a high soluble fiber content (4.2%); Early and Early (1987) [9] reported protein concentration between either 12.5% or 17.6%, in line with Teutonico and Knorr (1986) [25], or between 16.09% and 18.19%.

Agrawal *et al*., (2013) [2] studied to fortify extruded food with malted millets and defatted soy flour to improve its nutritive value. Refined wheat flour was incorporated and replaced with barnyard millet flour and defatted soy flour. Blends in the ratio of 90:00:10, 70:20:10, 45:45:10, 20:70:10 were evaluated for organoleptic score and defatted soy flour was kept constant. Blends 45:45:10 was superior than those made from control and other blends and recorded highest sensory score 7.82. The nutritive value of selected vermicelli (blends 45:45:10) was found to be as follows moisture 8.10 percent, protein 15.23 percent, total carbohydrate 68.40 percent, crude fat 2.58 percent, crude fibre 3.5 percent and ash 2.20 percent. The developed product can serve to fulfill the protein requirement of the community.

Jatav *et al.*, (2016) [13] developed amaranth based pasta with incorporation of 10%, 20%, 30%, and 40% amaranth flour. These all are evaluated for sensory qualities. The results revealed that chemical analysis shows that the amaranth flour enhanced the protein, fiber, and sugar content of the pasta while maintaining an ideal level of fat. Based on sensory attributes, the findings indicated the importance of combining wheat with amaranth flour in the formulation of pasta containing 20% amaranth flour, which produced better-quality, more nutrient-dense pastas

Tanimola *et al.*, (2016) [24] studied chemical, functional, and rheological properties of amaranth flour, as well as the sensory attributes of the resulting amaranth flour-based paste. Amaranth flour contains a protein content of 14.60%, crude fat content of 8.28%, ash content of 1.87%, total carbohydrate of 71.09%, and a food calorific value of 417.28 kcal, as per the results of the proximate composition. The amaranth flour contains 6.27 mg/100 g of zinc, 5.96 mg/100 g of Mn, 18.23 mg/100 g of magnesium, 11.00 mg/100 g of iron, and 33.29 mg/100 g of Ca, according to mineral analysis.

Tripathi and Mogra, (2020) [26] revealed that the present investigation was designed to develop high protein product (noodles) by incorporation of amaranth flour. Amaranth flour was incorporate in the ratio of 20, 30, 40, 50, 60 and 70 percent in the wheat flour. The higher score of overall acceptability was 7.70±0.10 for 50 percent substitution of amaranth flour after control and the minimum as 6.67±0.25 for the 70% amaranth flour noodles. The result obtained in which the amaranth flour addition up to 30% is noticeable to improve some nutritional properties and 50% for sensory properties; significant increase in the protein (13.22g) when compared with control (12.07g). 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.

Patel *et al.*, (2022) [18] revealed that Amaranth (Family-Amaranthaceae) grain is a highly nutritive and low- gluten pseudo-cereal with a high content of proteins, vitamins and minerals compared to true cereals. Amaranth fortified pasta could be a good way for combating nutrient deficient diet and malnutrition. Therefore, the present investigation was carried out to make pasta with the incorporation of amaranth flour (20%, 40%, 60%, 80% and 100%), semolina (10% and 20%) with the replacement of refined wheat flour. In all treatment 1% guar gum powder were added. Therefore, the present study was to evaluate organoleptic and nutritional characteristics of value-added pasta from amaranth flour so that these can be used to solve the problem of malnutrition and other micronutrient deficiency among the population.

Materials and Methods

The present investigation was conducted during the year 2020–21 at the Department of Food Science and Technology, College of Agriculture, JNKVV, Jabalpur (M.P.) 482004.

Procurement and preparation of raw materials

Amaranth grains, refined wheat flour, semolina, edible oil and salt were procured from local market, Jabalpur, Madhya Pradesh (487002). Guar gum powder was purchased from Online shopping app.

For Amaranth flour preparation: Amaranth grains were cleaned and milled into flour using a flour machine (Mili-Domestic flour mill). The milled amaranth flour was then sieved by using 100 mesh screens to obtain uniform flour particles. The flour was stored by packing in airtight plastic container.

Blending formulation

11 types of composite flour were prepared by incorporating refined wheat flour, amaranth flour and semolina. Refined wheat flour and amaranth flour were blended in various proportions; semolina was used to replace 10% and 20% of the amaranth flour and refined wheat flour mixtures (blends). The following treatment combinations are shown in Table 1:

Preparation of value-added pasta

Pasta was prepared from various blends as shown in Table 1. Figure 1 shows a flow chart depicting the pasta preparation process. The composite flour was placed into the pasta making machine's (model No. KK-P-15) feeder and mixed for

around 5-10 minutes. After that, the appropriate amount of water was added to the pasta extruder's mixing chamber, and the mixture and water were kneaded for around 10-15 minutes to evenly distribute water throughout the composite flour particles. The amount of water utilized in the formulations ranged from 28 to 30%. The moist flour aggregate was extruded at room temperature using round die no. 37 by a power operated single screw cold extruder (pasta making machine) and cut into short pasta lengths. Freshly extruded pasta was steamed for 10 minutes in boiling water (102-105 ^{0}C). The steaming process was done with a household steamer. The steamed pasta was allowed to cool to room temperature (25 + 30 °C) before being dried for 3 h in a dryer at 65-70°C.The resultant dried pasta were packed in plastic container and polythene pouch for further analysis. The similar procedure was followed by Shobha *et al*., (2015) [20] who prepared maize based composite flour noodles.

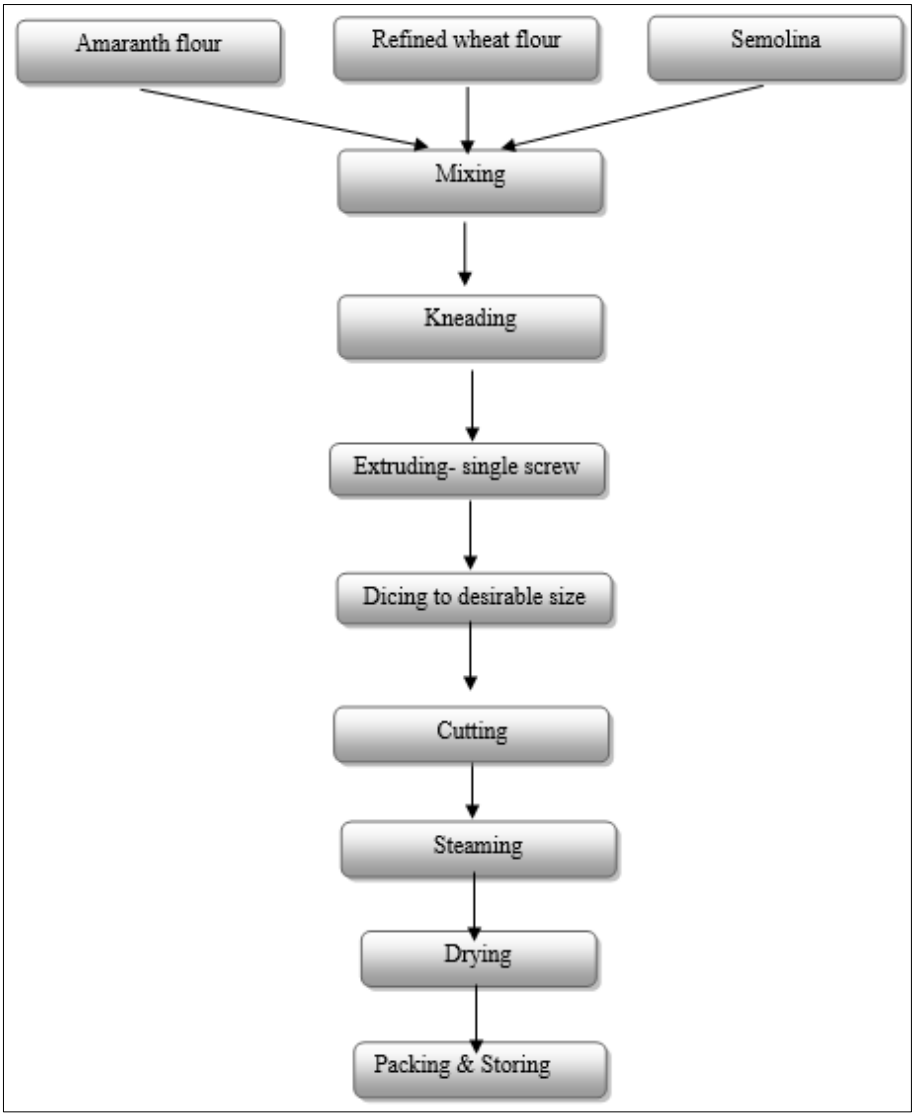

Fig 1: Flow chart of preparation of value-added pasta

Organoleptic evaluation of prepared cooked pasta

Organoleptic evaluation of the samples was done based on 9-point Hedonic scale, where 9=Like extremely, 8=Like very much, 7=Like moderately, 6=Like slightly, 5=Neither like nor dislike, 4=Dislike slightly, 3=Dislike moderately, 2=Dislike very much, 1=Dislike extremely for the sensory quality characteristics of the extrudate products (Pasta) such as colour, flavor, taste, texture and overall acceptability as described by Amerine *et al.*, (1965) [4]. This evaluation of cooked pasta samples was carried out in order to determine the various sensory quality characteristics of the different combination compared to the control. The pasta samples were cooked for organoleptic evaluation. Cooking time was determined by the method of AACC, (2000) [1]. 10 g pasta sample was weighed accurately and cooked into boiling distilled water (250ml) without addition of salt, which was kept at a rolling boil. Starting at 4 min mark, a sample was removed in every 30 sec intervals. It was placed between two glass plates and the cooking time of pasta was assessed as the time required for disappearance of the dry central core when gently squeezed. Sensory panelists (n=10) of Department of Food Science and Technology, College of Agriculture, Jabalpur; were given cooked pasta samples of all combinations along with control and score sheets were provided for recording their scores.

Chemical Analysis of raw materials and pasta samples

Moisture content of the samples was estimated by the basic

reference method AOAC, (2005) [6]. Ash content was determined by the basic reference method AOAC (2000) [5]. Fat content was estimated by standard method of analysis AOAC (2000) [5] using the automatic SOCS Plus Solvent Extraction System. The content of crude protein in a sample was determined by the standard method of AOAC (2000) using Pelican's KEL PLUS Automatic Nitrogen Estimation System. The carbohydrate content was determined by the difference using the formula: Total carbohydrate (g) = 100 – (weight in grams [protein + fat + moisture + ash] in 100 g of food. The content of crude fiber in a sample was estimated by the following the method of method AOAC (2005) [6]. The energy value of extruded product was calculated by factorial method. The energy values are 17 KJ/g (4.0 kcal/g) for carbohydrates, 37 KJ/g (9.0 kcal/g) for fat & 17 KJ/g (4.0 kcal/g) for protein. So, energy of extruded product was calculated by multiplying the carbohydrate, fat and protein content present in the sample by 4, 9 and 4 respectively using following formula (Merrill and Watt (1973): Energy (Kcal/100g) = 4 * Carbohydrate (%) + 9 * Fat (%) + 4 * Protein (%). The analyses were performed in triplicate.

Statistical analysis

Statistical analyses were performed with the help of OPSTAT software version OPSTAT 1.exe (Hisar, India). The data were statistically analyzed by using analysis of variance (ANOVA) technique (one way classification) in completely randomized design (CRD) with three replications as showed in Table 2, although ten (10) observations were analyzed in case of organoleptic evaluation. Significant difference between the treatments was calculated by using critical difference (CD) techniques at $p < 0.05$ level.

Results and Discussion

Organoleptic evaluation of cooked pasta

A trained and semi-trained 10-member panel conducted a organoleptic evaluation using a 9-point hedonic scale on the various quality attributes like color and appearance, taste, texture, flavour and overall acceptability, and the results are shown in Table 3. The intensity of liking and disliking on 9-point hedonic scale has been listed in materials and methods. Table 3 depicts the results of organoleptic scores of value added pasta made with various amounts of amaranth flour. The mean score of different quality attributes tabulated with statistical analysis. All the sensory attributes as 8.60 (colour and appearance), 8.70 (taste), 8.72 (texture), 8.54 (flavour) and 8.62 (overall acceptability) were found by control as compared to all other formulations as revealed in Table 3. It's apparently from the Table 3 that the overall acceptability mean score of value-added amaranth flour pasta ranged from (6.80 to 8.62). Among all the formulations, Sensory data indicated that the prepared pasta with up to 60% of amaranth flour and 10 percent semolina (T5) was obtained highest score of sensory attributes. Scores were observed in T5 sample 8.40 (colour and appearance), 8.12 (taste), 8.48 (texture), 8.54 (flavour) and 8.48 (overall acceptability than other pasta samples, while after the T5 sample with the increase of incorporation of amaranth flour, there was decrease in overall acceptability. Results are in conformity with the findings of Jatav *et al.*, (2016) [13] that developed standardize process of nutritious pasta by substituting normal ingredient with amaranth flour to improve quality of pasta. These findings are in accordance with the results of Tripathi and Mogra, (2020) [26] who investigated organoleptic and nutritional evaluation of value-added noodles from amaranth seed flour.

Chemical analysis of raw materials and value-added pasta

Proximate composition of raw materials

The moisture content of Amaranth flour, refined wheat flour(RWF) and Semolina were 10.49%, 10.87% and 11.36% respectively. The protein content of Amaranth flour was highest (15.87%) than RWF and semolina. Fat content was highest in Amaranth flour followed by RWF and semolina, the values 5.54%, 1.21% and 1.47% respectively. Fiber content of Amaranth flour was highest i.e. 6.31% while that of RWF and Semolina was 0.58% and 1.34% respectively. The Ash content of amaranth flour, RWF and semolina were 2.39%, 2.59% and 0.55% respectively. Carbohydrate content was highest was recorded in RWF (74.49%) followed by semolina and then amaranth flour. The values ranged- 65.72% to 74.49% as can be shown from Table 4.

Nutritional analysis of pasta samples

Moisture content

From the (Table 5), it was recorded that the value of lowest moisture content in T_{11} (8.07%) and highest moisture content in control (9.00%). Moisture content of ranged from 8.07% to 9.00%.

Ash

The maximum ash content was observed in T_{11} (3.62%) and minimum value in control (2.04%). Ash content ranged from 2.04% to 3.62%.

Carbohydrate

Total carbohydrate content was found to be from 68.30% to77.39% in different combinations where the highest value in control (77.39%) and lowest value in T_{11} (68.30%).

Protein

The protein content of pasta ranged from 10.81% to 15.87%. The minimum protein content in control which was the value 10.81% followed by increased significantly in T_1 to T_{11} where maximum value in T_{11} (15.87%).

Fat

Fat content of pasta in different combinations. (Shown in table 5) It was reported from the results that fat content varies between 0.77%to 4.14%. Among all the samples, maximum at content was found in T_{11} (4.14%), whereas minimum fat content was showed in control sample (0,77%).

Fiber content

The crude fiber content ranged from 0.91% to 6.39% in various combinations. The highest fibre content was observed in T11 formulation (6.39%) and minimum presents in control (0.91%).

Energy value

The energy value of the pasta is directly related to its protein, fat and carbohydrate content. The energy value of sample T11 was found to be most while the control had the least amount, the value ranging from 359.68kcal/g to 373.94kcal/g as observed from Table 5. Significant results of proximate analysis were obtained and fibre content and energy value also varied significantly.

From Table 5 shows that incorporation of amaranth flour increased protein, fat and fiber content, while decreasing carbohydrate content proportionately as compared to the control and showed significant difference ($p < 0.05$). Further it was noticed that replacement of 10% and 20% blends (Amaranth flour and Refined wheat flour) by semolina, the amount of protein, fat and fiber decreases but amount of carbohydrate increases, respectively. The results agreed with Jatav *et al.,* (2016) [13] who prepared development and quality evaluation of amaranth flour pasta. Similar results were reported by Singh J *et al.,* (2018) [21] in their study the nutritional profiling showed a significant ($p < 0.05$) increase in the protein, fat, ash, while a significant decrease in moisture and carbohydrate with the increase of cocoa powder concentration. The protein, fat, and carbohydrate levels of a product have a direct impact on its energy value. A higher energy value indicates that the consumed food is more energy dense and can give more energy when consumed. The energy value of sample T11 was found to be the maximum in contrast to the control which had the minimum value. The energy value of pasta increased as the percentage of amaranth flour increased among the samples. Similar results were showed by Mogra and Midha (2013) [26] who developed value addition of traditional wheat flour vermicelli. Vani and Mahinegalai (2004) [27] developed noodles with 35% incorporation of Colocassia leaves powder and found that protein, energy and iron contents were improved. The similar results were found in close agreement of Singh J *et al.,* (2018) [21].

Table 1: Blending formulations of Amaranth flour, Refined Wheat flour

Treatments	Amaranth flour (%)	Refined wheat flour (%)
(Control)	0	100
T1	20	80
T2	20	80
T3	40	60
T4	40	60
T5	60	40
T6	60	40
T7	80	20
T8	80	20
T9	100	0
T10	100	0
T11	100	0

Other ingredients used in treatments- Guar gum (1%), Salt (1.5%), Oil (2%), Water

Table 2: The skeleton of analysis of variance

S. No.	Source of variance	D.F.	SS	MSS	F calculated	F table value (5%)
1	Treatments	(t-1)	TSS	TMS	TMS/EMS	
2	Error	(n-t)	ESS	EMS		
Total	(n-1)					

T= number of treatments, N= number of observations, D.F.= degree of freedom,
TSS= treatment sum of squares, ESS= error sum of squares

Table 3: Organoleptic evaluation of cooked pasta incorporated with amaranth flour

Treatments	Colour and appearance	Taste	Texture	Flavor	Overall acceptability
Control	8.60	8.70	8.72	8.54	8.62
T_1	8.10	8.50	8.28	8.24	8.32
T_2	8.12	8.38	8.32	8.28	8.30
T_3	8.16	8.22	8.34	8.32	8.28
T_4	8.20	8.16	8.36	8.36	8.22
T_5	8.40	8.12	8.48	8.54	8.48
T_6	7.80	7.80	7.86	8.20	8.20
T_7	7.56	7.50	7.68	7.68	7.72
T_8	7.56	7.28	7.56	7.56	7.60
T_9	6.78	7.08	6.96	6.98	7.04
T_{10}	6.70	6.50	6.78	6.80	6.84
T_{11}	6.36	6.34	6.40	6.78	6.80
Mean	7.72	7.72	7.81	7.86	7.87
SE(m)	0.187	0.207	0.158	0.162	0.152
CD @ 5%	0.532	0.591	0.451	0.461	0.432
F-value	F= 17.18 (1.99) S^*	F= 22.50 (1.99) S^*	F= 14.10(1.99) S^*	F= 17.46(1.99) S^*	F= 18.65(1.99) S^*

The values are represented in Mean derived for experiments (n=10). The values denoted significantly different ($p<0.05$). S^* Significant

Table 4: Proximate composition of raw materials used in pasta combinations

Parameters	Amaranth flour	Refined wheat flour	Semolina
Carbohydrate (%)	65.72	74.49	74.19
Protein (%)	15.86	10.83	12.43
Fat (%)	5.54	1.21	1.47
Moisture (%)	10.49	10.87	11.36
Ash (%)	2.39	2.59	0.55
Crude fiber (%)	6.31	0.58	1.34

The values are represented in Mean derived for triplicate experiments (n=3). The values denoted significantly different ($p < 0.05$).

Table 5: Nutritional analysis of value-added pasta incorporated with amaranth flour

Treatments	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Fibre (%)	Energy value (Kcal/100g)
Control	9.00	2.04	10.81	0.77	77.39	0.91	359.68
T1	8.97	2.34	11.00	1.70	76.00	1.72	363.26
T2	8.93	2.15	10.87	1.20	76.86	1.65	361.67
T3	8.89	2.50	11.91	2.77	73.93	2.75	368.32
T4	8.84	2.40	11.86	2.15	74.75	2.57	365.83
T5	8.81	2.95	12.97	2.82	72.45	3.76	367.07
T6	8.78	2.74	12.66	2.81	73.02	3.50	367.96
T7	8.52	3.18	13.70	3.42	71.19	4.78	370.28
T8	8.50	3.11	13.12	3.11	72.16	4.34	369.10
T9	8.42	3.25	14.92	3.55	69.86	5.81	371.11
T10	8.21	3.14	14.65	3.42	70.58	5.32	371.69
T11	8.07	3.62	15.87	4.14	68.30	6.39	373.94
Mean	8.66	2.78	12.86	2.65	73.04	3.62	367.49
SE(m)±	0.19	0.07	0.128	0.117	0.312	0.09	0.985
CD @ 5%	0.558	0.205	0.377	0.343	0.916	0.265	2.893
F-value	F= 2.63(2.22) S*	F= 50.59(2.22) S*	F= 74.67(2.22) S*	F= 75.32(2.22) S*	F= 83.23(2.22) S*	F= 378.81(2.22) S*	F= 18.63(2.22) S*

The values are represented in Mean derived for triplicate experiments (n=3). The values denoted significantly different ($p < 0.05$). S* Significant

Conclusion

Amaranth's seeds are increasingly being incorporated into the diets of those who have poor diets or low nutrition as a result of poverty or other factors. They suffer from illnesses like anorexia, among others. When there must be sufficient protein because it is a pseudo-cereal that is packed with nutrients in a ratio that is balanced and contains dietary fibre, pertinent lipids, necessary amino acids, calcium in large quantities and antioxidants, iron and manganese. Amaranth grain have nutritional and health benefits. In present study, popular extruded food pasta was selected and enriched by incorporation with amaranth flour and semolina. On the basis of organoleptic attributes, pasta when incorporated with 60% amaranth flour and 10% semolina (T_5) resulted in better sensory parameters and nutritionally superior in protein as compare to control. Nutritional composition i.e. protein content, fat content and fibre content increased significantly simultaneously in 10% and 20% semolina formulation with the increase proportion of amaranth flour, while carbohydrate content decreased significantly.

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