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Study on Physical and Functional Characteristics of Amaranth Fortified Pasta

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ABSTRACT: 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. Pasta is a cereal-based food product popular in India, due to its ease of cooking and high palatability but low in nutrient content. 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. Bulk density, oil and water absorption capacity of uncooked pasta differed significantly ($p<0.05$) from 0.73 to 0.83 g/ml, 181.00 to 200.91% and 204.98 to 279.71% respectively. The cooking parameters varied significantly ($p<0.05$) and therefore the cooking time ranged from 4.07 to 6.73 min. Cooked-weight, rehydration percentage, swelling index and total gruel loss values of pasta varied from 18.70 to 21.05 g, 85.53 to 107.88%, 1.98 to 2.90 and 0.91 to 2.11 respectively.

Keywords: Amaranth flour, Pasta, Physical properties, Pseudo-cereals, Extruded food

INTRODUCTION

Amaranth (*Amaranth cruentus*) (Family-Amaranthaceae) is a pseudo-cereal having dual characteristics of a cereal and leguminous seed (Amaya-Furfan *et al*., 2005; Caselato-sousa and Amaya-Farfan 2012) and generally called as 'pigweed' which is small seeded ancient crop that is grown for some 8 thousand years with encouraging economic and nutritional value. Amaranth is known as 'Ramdana' or 'Rajgeera' which meaning God's grain and King's grain respectively. The names indicate the enormous importance and immense value of this grain. It has a high protein (12.5-19%) content with a rich amount of nutritionally critical amino acids such as methionine and lysine (0.73-0.84%) and high vitamin and mineral contents, such as riboflavin, niacin, ascorbic acid, calcium, and magnesium compared to other grains (Becker *et al.*, 1981; Bressani, 1989). Low gluten and high nutrient rich pasta could be a good for combating nutrient deficient diet and useful for malnourished people and also good for celiac disease patient. In health aspects it is useful for the health benefits decreasing plasma cholesterol levels protecting the heart, immunity booster, exerting an anti-cancer activity, reducing blood glucose levels and combat to hypertension and anemia (Verginia *et al.,* 2014). Celiac disease is manifested as an enteropathy of sensitivity to gluten in genetically predisposed individuals. It's characterized by constant injuries of intestinal mucosa caused by gluten ingestion and also the mucosa can completely recover thanks to the whole elimination of gluten from the diet (Molberg *et al.*, 2000).

According to Mudgil *et al.* (2014) Guar gum (GG) is obtained from the ground endosperm of seeds from an annual plant commonly called cluster bean (*Cyamopsis tetragonolobus* L.). It is largely used in the form of guar gum powder as additive in food for food stabilization and as fiber source. It is a natural, water swelling, nontoxic and nonionic polysaccharide. The beneficial effects of guar gum are in the control of many health problems *i.e*. diabetes, bowel movements health disease and colon cancer.

Pasta products that are largely consumed everywhere were traditionally manufactured from *Triticum turgidum* semolina, known to be the most effective material sui for pasta production (Feillet and Dexter 1996). Utilization of *Triticum durum* for snack and extruded foods has been well identified by Toepfer *et al*., (1972). As wheat derived staple food, pasta is second to bread in world consumption. Its worldwide acceptance is attributed thanks to its low cost, easy preparation, versatility, sensory attributes and long time period were studied by Mariani-Constantini (1988).

Kays *et al.* (2006) reported guar seed endosperm could be a source of water-soluble gum which is employed as stabilizer, emulsifier and thickener in various food products and contributes to soluble dietary fiber (SDF) portion of seed total dietary fiber (TDF). TDF and SDF, respectively, made up 52–58% and 26–32% of seed dry weight.

Gatade and Sahoo (2015) reported steaming is a key process in the manufacture of instant noodles. For the production of instant noodles, a high degree of starch gelatinization is required. Steaming time is longer for hot-air dried noodles than for deep-fried noodles. Steam induces gelatinization of starch prior to drying which improves the water uptake capacity of noodles.

Makdoud and Rosentrater (2017) studied make gluten free pasta using amaranth, quinoa and rice flours, water and egg. Color analysis, water activity, cooking loss, texture, etc. were determined, the best pasta formulation was 10% amaranth flour, 40% quinoa flour, and 50% rice flour, with 18% eggs whites and 39% water. 80% of consumer acceptability was deducted.

Mohammed *et al.* (2018) developed instant noodles with incorporation of fenugreek leaves puree they find out that when the percentage of fenugreek leaves puree increases the cooking time, cooking losses, bulk density, water absorption capacity and solubility index decreases whereas cooked weight, water uptake and swelling capacity increases.

The functional properties of raw amaranth flour suggest its feasibility that it can be used as an alternative to other flour-based foods frequently consumed by Indians, which in turn opens up a wide range of opportunities for its usage in the food industry. Instant noodles are one of breakfast and staple cuisine of East Asian countries, whose consumption is steadily increasing day by day throughout the world. Noodles, being a poor source of proteins due to use of refined flour in its development. Therefore, now it is required to fortify noodles with protein and fiber rich substances which may improve not only nutritional value but also functional characteristics (Pakhare *et al.*, 2018). So, by keeping these points in view a study was carried out with an objective to optimize the process for development of amaranth flour fortified pasta and to assess the physical and functional characteristics.

MATERIALS AND METHODS

The present study was carried out in the Department of Food Science and Technology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, during the year 2020-2021. The numerous experimental approaches, materials, and methodologies utilized in the production of pasta by incorporating of amaranth flour, as well as the quality assessment of the finished product.

A. Procurement and preparation of raw materials

Amaranth grains, refined wheat flour, semolina, edible oil and salt were procured from local market, Jabalpur, Madhya Pradesh (482004). Guar gum powder was purchased from online shopping app. Amaranth grains were cleaned and milled into flour using a flour machine for preparation of Amaranth flour.

B. Formulation of composite flour

Total 12 types of flour were prepared by incorporating refined wheat flour (RWF), amaranth flour (AF) and semolina (S). 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). These formulations are as RWF:AF:S-100:0:0(Control), RWF:AF:S-80:20:10(T1), RWF:AF:S-80:20:20(T2), RWF:AF:S-60:40:10(T3), RWF:AF:S-60:40:20(T4), RWF:AF:S-40:60:10(T5), RWF:AF:S-40:60:20(T6), RWF:AF:S-20:80:10(T7), RWF:AF:S-20:80:20(T8), RWF:AF:S-0:100:10(T9), RWF:AF:S-0:100:20(T10), RWF:AF:S-0:100:0(T11).Other ingredients were used in treatments- Guar gum (1%), Salt (1.5%), Oil (2%), Water as required.

C. Development of product

The 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 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°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 similar procedure was followed by Shobha *et al*. (2015) who prepared maize based composite flour noodles. The process of amaranth flour fortified pasta preparation is shown in the flow chart given in Fig. 1 and ready to cook pasta is shown in Fig. 2.

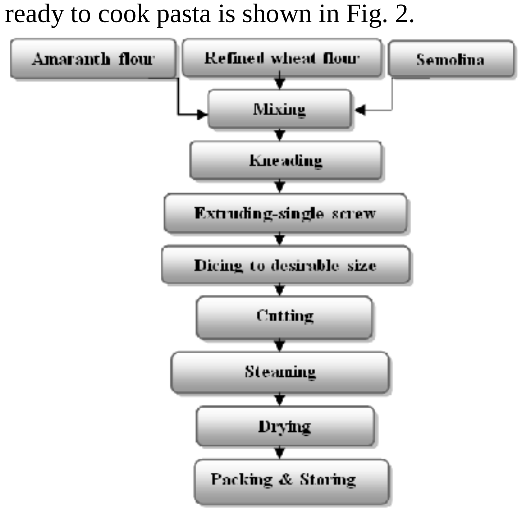

Fig. 1. Flow chart of preparation of Amaranth flour fortified pasta.

Fig. 2. Amaranth flour fortified pasta with control.

D. Physical and functional properties

(i) Bulk density of raw materials and products: The bulk density of samples was calculated by the method of Okaka and Potter, (1977). 50 g sample was weighed accurately and transferred to 100 ml graduated measuring cylinders. Sample was tapped 20 to 30 times, until no noticeable change in volume. The bulk density was determined as weight per unit bulk volume of the sample (g/ml). It was calculated by using equation mentioned.

Bulk Density (g/ml) = [Weight of sample (g) / Volume of sample (ml)]

(ii) Oil absorption capacity of raw materials and products: The oil absorption capacity was determined by following method of Sosulski *et al.* (1976). (1.0g) sample was directly weighed into 15 ml graduated centrifuge tube and 10ml refined soybean oil was added to it and kept at ambient temperature for 30 min and centrifuged for 25 min at 3200 rpm. Excess oil was decanted and each sample was allowed to drain by inverting the tube over absorbent paper. Oil absorption capacity was expressed as percent oil bound per gram of the sample.

$$\text{OAC (\%)} = \frac{\text{Weight of sample(g) + weight of centrifuge tube (g)] - Weight of empty centrifuge tube(g)}}{\text{Weight of sample (g)}} \times 100$$

(iii) Water absorption capacity of raw materials and products: The water absorption capacity was determined by the centrifugation method of Sosulski *et al.* (1976). 1.0g sample was weighed and then, taken to it in 15ml centrifuge tube and 10 ml distilled water was added to it. The sample was shaken for 60 min. and centrifuged at 5000rpm for 30 min. Excess water was decanted and each sample was allowed to drain by inverting the tube over absorbent paper. Water absorption capacity was expressed as percent water bound per gram of the sample. This process was done in triplicate.

$$\text{WAC (\%)} = \frac{\text{[Weight of sample(g) + weight of centrifuge tube (g)] - Weight of empty centrifuge tube(g)}}{\text{Weight of sample (g)}} \times 100$$

(iv) Hunter colour measurement of products: The colour scanning machine (Model: Colour Flex EZ)) was used for measurement of colour of pasta samples. The colour was measured by using CIELAB (1976/D65) scale at 10 observers at D65 illuminate. The instrument was calibrated before placing black tile and white tile provided with the instrument. Once the instrument was standardized. It was ready to measure the colour of pasta. It can also be crosschecked by placing the white tile, which were provide for the L, a, b, C and H Values. The pasta sample was placed in sample cup. The deviation of the colour of the sample to standard was also observed and recorded in the computer interface. It provides readings in terms of lightness (L*-value), redness (a*-value) and yellowness (b*-value) of sample. L* is a measure of the brightness from black (0) to white (100). Parameter a* describes red green colour with positive a* values indicating redness and negative a* values indicating greenness. Parameter b* describes yellow-blue colour with positive b* values indicating yellowness and negative b*- values indicating blueness.

E. Cooking characteristics of cooked pasta

(i) Optimum cooking time: Cooking time was determined by the method of AACC, (2000). 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 between two glass plates, indicating penetration of water in the core of pasta.

(ii) Cooking loss or total solid/gruel loss: 250 ml water was taken in the beaker and heated over hot -plate or any sui burner till water boils. 25 g dry pasta was added and stirring thoroughly with glass rod. Cook for 10 min with occasional stirring. After cooking, allow the sample to drain for 5 min. The volume of total gruel was measured in which 20 ml of the gruel was pipette out, after stirring well to given an even distribution of the solid content and put into tared petri-dish. Petri-dish was transferred to a hot air oven to maintain at 105 + 2°C and dried to constant mass. Cooking loss was expressed as g/100 g. Cooking loss was carried out in triplicates. Total gruel loss was calculated by following formula as per the method of (ISI 1993):

$$\text{Total solids in gruel (\% by mass)} = \frac{(M_2 - M_1) * V}{5}$$

Where,

M_1 = mass of empty petri dish (g)

M_2 = mass of petri dish with total solids (g)

V = vol of gruel (ml)

(iii) Percent rehydration: Percent rehydration was calculated by the method Hormdok and Noomhorm (2007). For determination of percent rehydration, pasta sample were cooked 1 min more than their respective cooking time. The cooked pasta was then washed with water and drained for 2 min. Weight was taken to calculate percent rehydration. Percent rehydration was calculated by the following formula:

$$\text{Rehydration (\%)} = \frac{\text{Weight of cooked pasta (g) – weight of uncooked pasta (g)}}{\text{Weight of uncooked pasta (g)}} \times 100$$

(iv) Cooked weight: Cooked weight was defined as the weight gain of the pasta during cooking and indicated the amount of water that was absorbed and was therefore an index for the swelling ability of the pasta. Instant pasta 10 g was cooked in 300 ml of distilled water in a beaker till completion of rehydration duration procedure as described by the Kamble *et al.* (2018). The pasta was taken out and left to cool for 5 min at room temperature. The cooled cooked pasta was then reweighed. The cooked weighed was expressed in grams.

(v) Swelling index: The swelling index (SI) of cooked pasta was determined according to the procedure described by Cleary and Brennan (2006). 10 g of raw pasta was cooked in a glass beaker with 20 times its quantity of boiling distilled water for 10 min over a water bath maintained at 100°C. After cooking process, the water was strained out and the cooked pasta was dried to remove surface moisture by filter paper. The SI was expressed as follows:

$$SI = \frac{\text{Weight of cooked pasta(g) - Weight of cooked pasta after drying(g)}}{\text{Weight of cooked pasta after drying (g)}} \times 100$$

F. Statistical analysis

The independent observations of each sample for various analysis were taken and mean of these observations was used for statistically analysis. The data obtained was subjected to analysis of variance (ANOVA) using complete randomized design. Statistical analysis was performed with the help of OPSTAT software version OPSTAT 1.exe (Hisar, India). The critical difference at p<0.05 was estimated. The skeleton of analysis of variance (ANOVA) for completely randomized design is indicated in Table 1.

Table 1: The skelet on of analysis of variance.

Source of variance	**d.f.**	**SS**	**MSS**	**F calculated**	**F table value(5%)**
Treatments	(t-1)	TSS	TMS	TMS/EMS	
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

RESULTS AND DISCUSSION

A. Physical and functional properties of raw materials and pasta products

(i) Bulk density: The data presented in Table 2 and 3 showed that bulk density of amaranth flour, refined wheat flour and semolina was 0.61 g/ml, 0.64 g/ml and 0.79 g/ml respectively. Similarly, the bulk density for pasta was highest in control (0.83g/ml) and lowest in T11 (0.73g/ml). Bulk density is a good attribute for determining the mixing quality of particulate matter and helps in indicating the relative amount of material handling attributes (Dhankhar *et al.*, 2019). The present study was observed that bulk density showed significantly decrease from control to T11 with an increase in amaranth flour. A similar result has been reported by Mohammed *et al.* (2018); Singh *et al.*, (2018); in their studies on studies on functional and textural quality of noodles incorporated with fenugreek leaves and optimization of a process for cocoa-based vermicelli, respectively.

Table 2: Physical and functional properties of raw materials.

Raw materials	**Bulk Density (g/ml)**	**Oil absorption capacity (%)**	**Water absorption capacity (%)**
Amaranth flour	0.61	201.57	215.44
Refined wheat flour	0.64	205.83	238.92
Semolina	0.79	195.30	211.53

Table 3: Physical and functional properties of amaranth flour fortified pasta.

Treatments	**Bulk density (g/ml)**	**Oil absorption capacity (%)**	**Water absorption capacity (%)**
Control	0.83	200.92	279.71
T_1	0.82	199.62	268.35
T_2	0.82	197.59	261.63
T_3	0.80	196.39	258.09
T_4	0.79	195.51	238.79
T_5	0.78	191.98	231.83
T_6	0.78	191.18	218.89
T_7	0.77	190.64	218.30
T_8	0.76	190.17	211.39
T_9	0.76	188.42	208.91
T_{10}	0.76	185.51	207.85
T_{11}	0.729	181.00	204.98
Mean	0.79	192.41	234.06
SE(m)$\pm$	0.012	2.093	2.442
CD @ 5 %	0.035	6.144	7.169
F-value	F= 5.51 (2.22) S^*	F= 7.90 (2.22) S^*	F= 118.68 (2.22) S^*

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

(ii) Oil absorption capacity: Oil absorption capacity (OAC) is influenced by the interactions between the non-polar amino acids side chains and hydrocarbon chains of lipid that also determine mouth feel and flavor retention of products. OAC of raw materials and pasta were observed and the values as depicted in Table 2 and 3. Flour of amaranth showed lesser oil absorption capacity (201.57%) as compared to refined wheat flour (205.83%) whereas in treatment combination the highest values obtained were of control (200.92%) and lowest value of T11 (181.00%). which contained 100% AF. Oil Absorption Capacity (OAC) increases the palatability of foods and critical assessment of flavor retention (Kinsella, 1976). The OAC is the ability of the product mix protein to absorb and retain oil, which in terms influence the texture and mouth feel of food products. Similar trend was observed on oil absorption capacity. OAC decreased significantly from control to T11with the increase of amaranth flour and semolina (Table 2 and 3). The increase in amaranth flour were statistically significant ($p<0.05$). The results could be supported by various workers for different food other than amaranth flour (Siddiq *et al.*, 2010).

(iii) Water absorption capacity: Studies on water absorption capacity of protein aceous material over a range of conditions are useful in assessing potential food application of new proteins. The water absorption capacity of different proteins may be determined to facilitate adjustments in food formulations in interchanging protein sources. The water absorption capacity was determined in flour and treatment combinations and the mean values are reported in Table 2 and 3. The water absorption capacity was found to be minimum in semolina (211.53%) whereas, the Amaranth flour was 215.44 and 238.92 in refined wheat flour. The Table 3 clearly indicates that only refined wheat flour pasta showed the highest (279.71%) and over other. Water absorption capacity of refined wheat flour is greater than amaranth flour and semolina (Table 2). Water absorption capacity is the ability of the product to associate with water under a condition where water is limiting, which is mainly dependent on proteins at room temperature (Otegbayo *et al.*, 2013). Gradual and progressive decrease in water absorption capacity was observed under all the treatments as compare to control (Table 3). It may be due to increase in amaranth flour percentage. Low water absorption capacity influenced the properties of extruded food. Table 2 and 3 reveled 215.44% water absorption capacity in amaranth flour and ranges from 268.35 to 204.98 in treatments which is quite close to value quoted by Agrawal *et al*. (2013) in unmalted millets 135 to 210 ml/100g, Shevkani *et al*. (2014) *i.e.* 209-243 % whereas Tripathi *et al*. (2019) found 134 percent water absorption capacity.

(iv) Hunter Colour analysis of uncooked pasta: As shown (Table 4), colour values of amaranth flour fortified pasta were varied. The range of L^* values in which Control (56.39) showed maximum lightness and T_{11} (44.43) showed lowest lightness on the basis of different percentage of amaranth flour. In the case that a^* values, highest value was obtained by Control (7.91) and lowest value was found by T_{11} (3.52). The b^* values of various treatments control (23.48) had the highest values and T_{11} showed lowest value (11.50). Data depicted in Table 4 the hunter colour L*(Lightness), a*(Redness), b*(Yellowness) values of pasta samples varied from 44.43-56.39, 3.52-7.91, 11.50-23.48 respectively. Increase in amaranth flour level from 20 to 100 % led to decrease the lightness as well as increase the darkness of the product but L^* values imultaneously little bit increases between treatments from T1 to T10 because of replacement of 10 and 20 % semolina. Pasta made from amaranth flour was darker than those made from durum wheat semolina. Overall results suggested that the dark colour intensity increased with the increasing amaranth flour level. The results were supported by Martinez *et al.* (2014), they reported that effect of amaranth flour on the L^*, a^* and b* value and sensory quality of bread wheat pasta whereas Bobade and Sharma (2017) found less b*value in honey-brown rice extrudate. The results are in accordance with Kaur *et al.* (2012). They reported that increase in bran level from 5 to 25 per cent led to a significant increase in the darkness of the product. Overall results indicated that the red colour intensity significantly increased with increasing bran level in flour. Gajula *et al*. (2008) reported that the barley bran had a reddish brown colour, thus higher levels of barley bran substitution led to darker products followed by products prepared with wheat, rice and oat bran.

B. Cooking quality of cooked pasta

The data related to cooking quality parameters in term of cooking time, cooked weight, total solid loss, rehydration % and swelling index for the samples analyzed are shown in Table 5.

(i) Cooking time: This is the optimum time which is taken by the pasta to cook and to become completely soft. The optimum cooking time of different blends was ranged from 6.73 to 4.07 min, showing significantly ($p<0.05$) high cooking time was noticed control (6.73 min) and lowest cooking time in T_{11} (4.07 min). This shows that the cooking is decreasing with increase by the incorporation of amaranth flour. This difference was observed due to varying combinations as shown in Table 5. The time needed to boil the pasta to the just fully cooked state is also known as cooking time. The differences in cooking time could be attributed to the difference in the gelatinization temperature of respective blend of starches (Benhur *et al.*, 2015). Addition of guar gum powder reduced cooking time. The Cooking time of pasta was ranged from 6.73 to 4.07 min. The control pasta was taken maximum time (6.73 min.). This could be due to the high starch content and lower gelatinization thus achieved. The similar results were found in close agreement of Gatade and Sahoo (2015).

(ii) Total gruel loss: cooking loss indicates the ability of the pasta to maintain structural integrity during the cooking process. The minimum cooking loss were recorded in control (0.91%) followed by T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and they were on par with each other as shown in Table 5. Cooking loss values increased significantly as the amount of amaranth flour increased in the combinations. The total gruel loss or cooking loss is the amount of solid loss in the cooking water, it is due to high solubility of starch. it shows the ability of pasta to resist structural breakdown during cooking. Higher cooking loss (2.11%) in blended pasta as compare to control (0.91%) this is 41%, has been due to structural discontinuity of the protein network as with the addition of other flour (Ahmed *et al.,* 2015). The gruel loss of pasta was increased due to addition of amaranth flour. Additions of high-fiber materials with WF affect negatively the quality of pasta products, including higher cooking loss (Martinez *et al.,* 2009). Slightly higher values were found and these findings were coincided by the findings of Ahmed *et al.* (2015). who were assessed for suitability in noodles blending wheat flour and broken rice flour at various levels.

(iii) Cooked weight: As per Table 5, maximum cooked weight of pasta was observed in control (21.05g) and lowest value was recorded in T_{11} (18.70g). The Cooked weight is the amount of weight it has after it has been cooked. The increased water absorption capacity is also an indicator for the increased cooked weight of the food samples (Ahmed *et al.,* 2015). According to Yadav *et al.* (2014); Manthey *et al.* (2004), the higher the concentration of protein content in the product, the lower the starch would be able to absorb water, thus the cooked weight of the product decreases. The cooked weight of pasta decreased significantly with an increase in the amaranth flour incorporation (21.05 to 18.70), which has low water absorption capacity. The similar results were reported in close agreement of Kamble *et al.* (2018).

(iv) Rehydration percentage: This shows the ratio of weight of cooked pasta to the weight of uncooked pasta and may affect the eating quality of pasta. The maximum rehydration percentage was found in control (107.88%) and minimum value of this was recorded in T11 (85.53%) as shown in Table 5. This is the ratio of weight of cooked pasta to the weight of uncooked pasta. This ratio affects the cooking qualities and texture of noodles. Present results are amaranth base pasta with the result 107.88 to 85.53% are similar to Yadav *et al.* (2014).

Table 4: Hunter color analysis of uncooked Amaranth fortified pasta.

Treatments	Hunter colour value		
	L* (Lightness)	a* (Redness)	b* (Yellowness)
Control	56.39	7.91	23.48
T_1	54.08	6.98	22.60
T_2	54.33	6.83	22.52
T_3	48.33	6.81	22.38
T_4	48.52	6.77	22.14
T_5	47.53	6.59	20.98
T_6	47.66	6.49	20.57
T_7	46.68	5.98	20.26
T_8	46.53	5.94	20.21
T_9	45.40	5.62	13.06
T_{10}	45.42	4.20	11.77
T_{11}	44.43	3.52	11.50

Table 5: Effect of guar gum powder and steaming on cooking quality of Amaranth flour fortified pasta.

Samples	Cooking time (min)	Cooked weight (g)	Swelling index	Total gruel loss %	Rehydration %
Control	6.73	21.05	1.98	0.91	107.88
T_1	5.86	19.96	2.06	1.11	104.83
T_2	5.47	19.85	2.18	1.56	103.16
T_3	5.38	19.82	2.27	1.63	96.30
T_4	5.34	19.67	2.28	1.68	95.76
T_5	5.14	19.65	2.40	1.68	95.49
T_6	5.13	19.64	2.54	1.78	94.01
T_7	5.11	19.23	2.74	1.80	89.73
T_8	4.64	19.13	2.77	1.87	89.08
T_9	4.56	19.05	2.78	1.92	88.64
T_{10}	4.33	18.78	2.79	2.09	87.38
T_{11}	4.07	18.70	2.90	2.11	85.53
Mean	5.15	19.54	2.47	1.68	94.81
SE(m)$\underline{+}$	0.107	0.216	0.093	0.11	0.989
CD @ 5 %	0.314	0.633	0.272	0.324	2.904
F-value	F= 44.87(2.22) S^*	F= 8.69 (2.22) S^*	F= 11.90(2.22) S^*	F= 10.41 (2.22) S^*	F= 54.19(2.22) S^*

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

(v) Swelling index: It is indicated the ability to absorb water by the starch and protein during cooking that is utilized for the starch gelatinization and protein hydration. The maximum and minimum value of swelling index was recorded in T_{11}(2.90) and control (1.98), respectively and they were on a par with each other as shown in Table 5. It is indicated the ability to absorb water by the pasta during cooking and increase in size. The results were coincided by the findings of Kamble *et al.,* 2018 where they prepared instant noodles incorporating moringa leaf powder with defatted soybean flour. Little higher values were found due to addition of guar-gum powder in which developed pasta had higher values of swelling index in comparison to control.

CONCLUSION

In the present study, popular extruded food pasta was selected and fortified by amaranth flour and semolina. On the basis of obtained results, physical and functional properties of pasta showed significantly decreases with the increasing percentage of amaranth flour. L^*value of pasta were found to decreases with the increase in the incorporation of amaranth flour. Overall results suggested that the dark colour intensity increased with the increasing amaranth flour level.Cooking qualities *i.e.* cooking time, cooked weight and rehydration percentage significantly ($p<0.05$) decrease with the increasing of amaranth flour while, swelling index and total gruel loss significantly ($p<0.05$) increased in the pasta sample containing higher concentration of amaranth flour in the formulations. Addition of guar gum powder (1%) to 100 g blends other than control had remarkable effect on pasta quality with regard to cooking properties. The steaming before dehydration revealed observable effect on all cooking quality parameters after rehydration. Ahead steaming treatment improved cooking quality and texture with respect to surface appeal. Therefore, incorporation of amaranth flour, guar gum powder and steaming treatment results enhanced physical, functional and cooling quality characteristics of pasta.

FUTURE SCOPE

Pasta fortified with amaranth is a nutrient-dense product that tastes great and maintains quality; consequently, promoting and selling this pasta will help to build a rural cottage industry and provide food security.

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Conflicts of Interest. None.

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