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Development of millet based snack for fasting

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Abstract
This present study was aimed to develop the nutritional composition and sensory attributes of pasta formulated with amaranth, water chestnut, and skimmed milk powder. The study systematically analyzed the protein, fat, fiber, carbohydrate, and ash content of the pasta to assess its nutritional profile. Additionally, sensory evaluations were conducted to determine consumer acceptance. Results indicate that the pasta formulation containing 70% amaranth and 20% water chestnut, supplemented with 10% skimmed milk powder, yielded the most favorable sensory scores. This formulation not only offers a unique flavor and texture but also provides enhanced nutritional benefits, including a higher protein content and improved overall acceptability. The findings underscore the potential of utilizing amaranth and water chestnut in pasta production to create a nutritious and appealing alternative to conventional wheat-based products.

Keywords: Amaranth, pasta, food, nutritional quality, water chest nut

Introduction
Pasta is one of the most common and popular staple foods. It is reported that about 14.3 million tons of pasta are produced annually worldwide. Pasta plays a key role in the Mediterranean Diet. WHO (the World Health Organization) and FAO (the Food and Agriculture Organization of the United Nations) described pasta as a healthy, sustainable, and quality food model. Moreover, in 2010, UNESCO (United Nations Educational, Scientific and Cultural Organization) declared pasta an intangible cultural heritage of humanity. One of the main reasons for the success of pasta is its nutritional profile. Indeed, pasta generally is very nutritious, due to its low amount of fats and readily digestible carbohydrate. Moreover, pasta can supply healthy components, such as fibre or prebiotics. The low cost and long shelf life of pasta make it popular with many diverse groups of consumers (Bresciani *et al.*, 2022) [3]. 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 (Patel *et al*., 2022) [8]. Therefore, with an aim to improve the nutritional quality and to add variety to the culinary experience, various non traditional ingredients such as amaranth, water chestnut, soybeen flour, flaxseed flour added to pasta.

Amaranth is a plant in the *Amaranthaceae* family, and it is currently known as a third millennium crop plant (Rastogi and Shukla, 2013) [11]. The genus amaranth is wide spread around the world and is distributed in temperate, subtropical, and tropical climate zones. The amaranth grain, also known as Rajgira (kingseed), Ramdana (seed delivered by the God), is a very nutritious pseudo-cereal with high protein content (12% to 18%) than many other cereals and is gluten-free (Bhat *et al.*,2015; Sneha and Haripriya, 2018) [2, 15]. Amaranth is high in lipids, fibre, and minerals (magnesium, phosphorus, copper, manganese, *etc*.) and is also strong in polyphenols (flavonoids), which have high antioxidant activity. Because of its nutritional characteristics, amaranth flour can also be used to make biscuits, muffins, pancakes, pastas, flat breads, and other baked products. The use of amaranth flour in the food chain is also reliant due to its functional qualities (Shevkani *et al.*, 2014) [14]. Amaranth is also a good source of iron and beta-carotene. Higher folic acid levels also aid to increase blood haemoglobin levels. In India, these are cultivated both in hills as well as plains. As a grain crop, it is cultivated on 30-40 thousand hectares. Amaranth has enormous promise for combating climate change and malnutrition.

It is gaining popularity because of its excellent nutritional content, fast growth, and tolerance to a variety of climatic and soil conditions (Niranjana and Kumar, 2017) [7]. Water chestnut *(Trapa natans)* is one of the important minor fruit crops growing in India. It is an aquatic nut crop produced primarily in the tropical and sub-tropical regions as a submerged plant community. It also flourishes in the soft, nutrient-rich waters of lakes, ponds, and streams with neutral to sluggish pH (Kundu and Joshi, 2012) [4]. It is also known as Singhara. 'Paniphal', 'Shinghoda', 'Pani Singhara', and 'Kubyakam' in different states of India. The crop can be dried and stored in the form of nuts and flour. They are consumed during fasting. Every year, 2.2 MT of chestnut are produced worldwide. In India, fresh nut yields range between 2500-3800 kg per ha of the pond area. (Rajkumar and Rajithasri., 2022) [10]

Milk proteins have been recognised for their nutritional and technological benefits. Milk proteins have high nutritional value when compared to other proteins due to their high quantity of essential amino acids and ease of digestion (Meisel, 1998) [5]. The chemical composition and physical qualities of milk powders serve as basic quality indicators. Milk powder manufacturers use worldwide many resources to ensure products with good sensory quality and longer shelf life (Pugliese *et al.*, 2017) [9]. Skimmed Milk Powder (SMP) has 10 to 20 percent fat, 37 percent carbohydrate and 6 percent minerals. It acts as functional food ingredient. The functional attributes are essentially those of the milk protein and include solubility, emulsification, gelation, water binding, whipping/foaming, viscosity, browning/colour and flavour/aroma (Tomar *et al.*, 2020) [17]. In India, during fasting people avoid cereal based food products. The water chestnut and amaranth are gluten free product and are presently being used during fasting. The amaranth is perfect fasting grain and it contains amino acid so it curtail hunger and also easy to digest. The product made from water chestnut and amaranth seed flour is consumed by the people during religious rituals like Navratras or religious fasting in India (Rupam and Jacob, 2019) [12]. The food extrusion process widely used in snack food processing industries. This versatile, convenient, and cost-effective cooking technology has successfully produced various types of food products, varying in shapes and sizes (Nidhi and Mohan, 2019) [6].

Materials and Methods

Selection of Raw Materials

The raw materials used in this investigation such as water chestnut, amaranth, skimmed milk powder were brought from the local market of Udaipur. All the raw materials were cleaned properly to make them free from dirt and foreign material.

Preparation of Flour

The cleaned amaranth grains and dried water chestnut kernels were milled separately in hammer mill. The milled flour was sieved with sieve size 0.32 mm to obtained fine flour. The flour was stored by packing in airtight plastic container.

Preparation of Pasta

Pasta was developed using cold extruder machine "La Parmigiana" model ANNA A45 (Pasta producing machine). Extrusion is a process that shapes material by pushing or forcing it through a die A die is a tool used for cutting, forming, or shaping material. In this investigation, a curl die (S-shaped) was used to prepare the product. The flour was weighed, and water was manually added until the dough reached the correct consistency. The material was dumped into the mixing chamber of the machine and mixed for few minutes. The machine is equipped with detachable electric pasta-cutter, mixing chamber, screw kneader and die holder. The machine has a centrifugal mixing hopper which allows the homogeneous hydration of the flours differently from the traditional mixers that continue moving the dough.

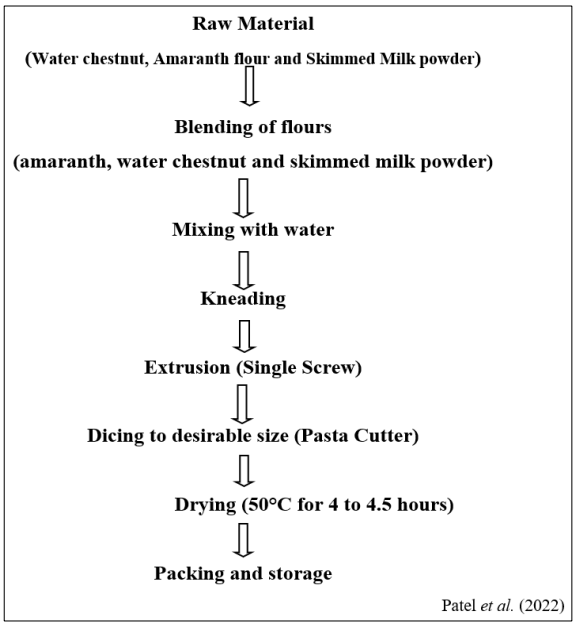

Fig 1: Processing flow chart of preparation of pasta

Table 1: Experimental design of various treatment combinations of millet based snack for fasting

Composition of flour (in per cent)				
Sr. No.	**Treatments**	**Amaranth flour**	**Water chestnut flour**	**Skimmed Milk Powder**
1	T_0	90	0	10
2	T_1	70	20	10
3	T_2	50	40	10
4	T_3	30	60	10
5	T_4	10	90	10

Organoleptic evaluation of prepared cooked pasta

The organoleptic evaluation of the samples was conducted using a 9-point Hedonic scale. The scale is defined as follows: 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, and 1 = Dislike extremely. This evaluation assessed the sensory quality characteristics of the extrudate products (pasta), including color, flavor, taste, texture, and overall acceptability.

Chemical Analysis of raw materials and pasta samples

The protein content in a sample was determined by the standard method of AOAC (2005) [1] by using Micro Kjeldahl technique, Ash content of sample was measured by (AOAC, 2005) [1], Fat content was estimated by standard method of analysis AOAC (2005) [1] by Soxhlet extraction method. The fiber content of the sample was measured according to AOAC methods (2005) [1]. The carbohydrate content was measured by using (AOAC, 2005) [1] method.

Statistical analysis

The analysis of variance was used to statistically examine the quality rating data. The sum-of-squares, degree of freedom, mean-square, and F-ratio were computed.

Results and Discussion

Protein

The protein content of the pasta samples ranged from 16.28% in T_0 to 10.11% in T_4, indicating a decrease in protein content as the proportion of amaranth flour decreased in the formulations (Table 2) For example, T_0, which contained 90% amaranth flour and 10% skimmed milk powder, exhibited the highest protein content, while T_4, which contained only 10% amaranth flour along with 80% water chestnut flour and 10% skimmed milk powder, had the lowest protein content. This trend suggests that amaranth flour is a significant contributor to the protein content of the pasta samples.

Fat

These values demonstrate that the fat content of the pasta varies with changes in the composition of both flours. Specifically, the fat content is higher in T_0 and lower in T_4, indicating that the proportion of amaranth and water chestnut flours influences the fat content of the pasta. The fat content ranges from 4.20% to 2.81% across the different treatments.

Fiber

It can be observed that the fiber content of the pasta varies with changes in the composition of both flour. Specifically, the fiber content is higher in T_0 and lower in T_4, indicating that the proportion of amaranth and water chestnut flours influences the fiber content of the pasta. The fiber content ranges from 5.62% to 1.36% across the different treatments.

Ash

These values demonstrate that the ash content changes with varying flour compositions in the pasta. The ash content in pasta ranges from 3.24 to 2.42%. The maximum ash (3.24%) was observed for T_0 and lower (2.42%) was observed in T_4.

Carbohydrate

The carbohydrate content ranges from 62.67% to 74.84% across the different treatments, with the highest value in the T_4 (74.84%) and the lowest value in T_0 (62.67%).

Table 2: Nutritional Profile of Pasta

Treatments	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Carbohydrate (%)
T_0	16.28	4.20	5.62	3.24	62.67
T_1	14.69	3.82	4.59	2.64	66.13
T_2	13.23	3.65	3.52	2.52	68.72
T_3	11.45	3.42	2.43	2.48	71.82
T_4	10.11	2.81	1.36	2.42	74.84

Sensory Evaluation

Sensory evaluation indicates the acceptability of the product. Acceptability of pasta was judged, on a nine-point hedonic scale. The sensory evaluation was carried out on the basis of flavour, taste, appearance and overall acceptability of the developed product. The quality was judged by the consumer panel team consisting of ten members. Overall acceptability of pasta ranged from 8.1 to 6.9. The treatment T_1 mostly accepted by sensory panel (overall acceptability 8.1) whereas, the treatment T_4 was rejected by sensory panel (overall acceptability 6.9).

Table 3: Sensory Evaluation

Treatments	Flavor	Taste	Texture	Overall Acceptability
T_0	7.1	7.6	7.3	7.3
T_1	7.9	8.3	8.1	8.1
T_2	7.5	7.9	7.7	7.7
T_3	6.8	7.4	7.3	7.1
T_4	6.6	7.1	7	6.9

Conclusion

The study demonstrated that acceptable ready-to-cook pasta can be developed using cold extrusion technology with amaranth and water chestnut flour. Quality analysis revealed marginal variations in pasta compositions. The highest protein (16.28%), fat (4.20%), fiber (5.62%), and ash (3.24%) contents were found in T_o, which contained 90% amaranth flour and 10% skimmed milk powder. T_1 had the second highest nutritional values, with 14.69% protein, 3.82% fat, 4.59% fiber, and 2.64% ash, consisting of 70% amaranth flour, 20% water chestnut flour, and 10% skimmed milk powder. Conversely, the lowest nutritional content was observed in T_4, which comprised 80% water chestnut flour, 10% amaranth flour, and 10% skimmed milk powder, with 10.11% protein, 2.81% fat, 1.36% fiber, and 2.42% ash. However, T_4 had higher carbohydrate content and energy compared to T_o, which had 90% amaranth flour and 10% skimmed milk powder. The pasta made from 70% amaranth flour, 20% water chestnut flour, and 10% skimmed milk powder (T_1) exhibited the best sensory attributes and overall acceptance in terms of texture, flavor, and color and overall acceptibilty. This combination of ingredients provided an optimal balance of nutritional content and sensory qualities, making it the preferred formulation for ready-to-cook pasta developed through this study.

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