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EVALUATION OF PHYSICO-CHEMICAL PROPERTIES OF *RIGATONI* PASTA ENRICHED WITH AMARANTH, RICE AND RAW BANANA

SALUNKE SHIVAM G[1], GENITHA IMMANUEL[2] AND RAUT KANCHAN R.[3]

[1,2]Department of Processing and Food Engineering,
Vaugh Institute of Agricultural Engineering and Technology,
Sam Higginbottom University of Agriculture, Technology and Sciences,
Prayagraj 211 007, U.P., India
[3]Institute of Bioscience and Technology, MGM University, Aurangabad 431 003, M.S., India

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Abstract– This study was conducted to evaluate the Physico-chemical properties of *Rigatoni* Pasta enriched with Amaranth, Rice and Raw banana. *Rigatoni* Pasta was prepared in six treatments in the ratio of 100:0:0 (T_0), 0:100:0 (T_{00}), 49:49:2 (T_1), 48:48:4 (T_2), 47:47:6 (T_3) and 46:46:8 (T_4) respectively. The different Physico-chemical properties of the pasta such as Moisture content, Fat, Ash, Protein, Soluble, Insoluble and total dietary fibre were determined. Sample T_2 of moisture content, fat, ash, protein, soluble, insoluble and total dietary fibre, i.e. 4.03, 3.19, 2.02, 14.33, 1.57, 5.62 and 7.01 % respectively, which gives the better quality and also more acceptable in terms of sensory. The protein content decreased slightly after addition of Raw banana flour, still the pasta had the good protein content. The raw banana flour incorporated pasta was rich in fiber content as both the amaranth and raw banana powder has good content of dietary fibers. Pasta is made from grain, one of the basic food groups in a healthy diet that also can include vegetables, fruits, fish, and poultry. It is a good source of energy and can give you fiber, too, if it's made from whole grain. That can help with stomach problems and may help lower cholesterol.

INTRODUCTION

Foods sensory qualities, behavior during production, storage, and consumption, and perceived quality are all ultimately determined by their physico-chemical properties. The quality of final product is primarily determined by the physicochemical properties of the food. Same is true in case of pasta products as well. This includes the amount of moisture, fat, ash, protein, soluble and insoluble fiber and total dietary fiber. Pasta made from healthy ingredients can be a good substitute for all people to consume on regular basis.

This study focused to evaluate the physico-chemical properties of pasta enriched with Amaranth, Rice and raw banana.

Amaranth flour, made from amaranth seeds, is an important commercial raw material with a distinctive chemical makeup that can be used to feed persons with food intolerances, including celiac disease patients. When compared to wheat protein, the protein from amaranth flour has the advantage of being primarily composed of albumins and globulins, with very little prolamine and no alpha-gliadin. Amaranth flour's elemental composition enables it to be suggested for use in the diets of celiac disease sufferers as well as healthy children and adults (Zharkova *et al.,* 2018).

Over half of the world's population uses rice as a staple food. In addition, rice has many unique functional properties, such as ease of digestion, white in color, bland taste, and hypoallergenic properties. Nearly all rice cultivars are grown to be consumed as intact kernels. In recent years, rice, especially rice flour, because of its unique functional properties, is being used in increasing numbers of novel foods such as tortillas, beverages, processed meats, puddings, salad dressing, and gluten-free breads. These novel foods usually require rice flours having known amylose and protein contents (Kadan *et al.,* 2003). Rice contains approximately 7.3% protein, 2.2% fat, 64.3% available carbohydrate,

[1]Research Scholar, [2]Associate Professor, [3]Research Scholar

0.8% fibre and 1.4% ash content (Zhou *et al.*, 2002).

Raw Banana is the fruit of the plant *Musa spp*. which grows under tropical and sub-tropical conditions. It is the most extensively grown fruit with a world total production of 113 million tonnes in 2016 (FAO, 2016). Considerable quantities of raw banana surplus to the requirement of fresh trade are available for processing in all the banana exporting countries in the world (FAO, 2016). The nutritional composition of raw banana is comparable to potato containing about 20% of carbohydrate, 1% protein, less than 1% fat, 100–130 calories and micronutrients; 0.4 mg iron and 0.6 mg niacin. High starch content of banana compared with the other fruits could be favourable for the extrusion process. However, high levels of sugars and moisture in the composition could lead to undesirable effect during the process and also on the product quality (Gamlath, 2008).

The aim of this study was to evaluate the physicochemical properties of *Rigatoni* pasta enriched with amaranth, rice and raw banana.

MATERIALS AND METHODS

Materials

The raw materials Amaranth flour (brand name: Jiwa organic) and Rice flour (brandname:24 mantra)were purchased from local market in Prayagraj and Raw banana flour was made in the research lab after drying the raw banana (Variety-Grand Naine G-9) and milled it. The flours were sieved using1 00 μm sieve.

Methods

For the preparation of *Rigatoni* pasta, Amaranth flour, Rice flour and Raw banana powder were mixed with an optimum amount of water in the mixing compartment of a pasta extruder (Make: La Monferrina Model: Dolly Pasta Extruder) for 10 min to obtain a uniformly mixed dough (30–32% moisture) at constant extrusion temperature of not more than 50 °C. The moist dough mixture was passed to a metal extruder attachment of the pasta machine fixed with an adjustable die (*Rigatoni* shaped). Extruded pasta was dried at 60 °C in a hot air oven for about 5-6 h to attain the final moisture of 6.5%.

The flow chart for the preparation of pasta is given in the Fig. 1.

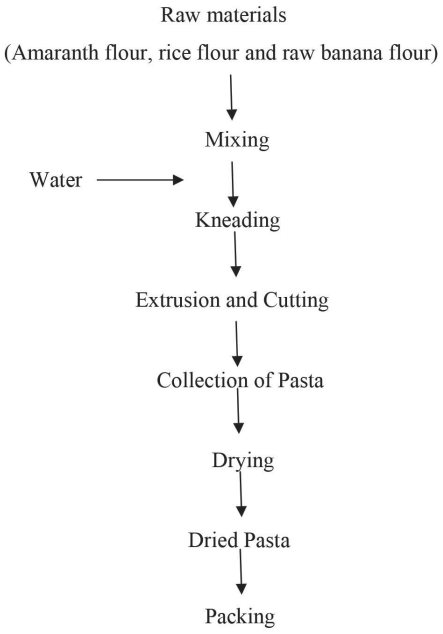

Fig. 1. Preparation of *Rigatoni* Pasta

Physico-chemical properties

Determination of Moisture Content of *Rigatoni* pasta

The moisture content in the sample was estimated according to the method of **AOAC (1990).**

Procedure

The instrument used for moisture determination was Hot air oven**.** About 5 g of sample was weighed in the moisture dish; previously air dried in the oven and weighed, then placed the dish in the oven maintained at the 120 ^{0}C for 1 h. It was cooled in the desiccators and weighed. The process of drying was repeated, cooling and weighing at 30 minutes intervals until the difference between the two consecutive weighing was less than 1 mg recorded as the lowest weight. Moisture Content was calculated using the formula 1

$$\text{Moisture content (\%)} = \frac{W1 - W2}{W1} \times 100 \quad \text{.. (1)}$$

Where,

W_1 = weight in g of the dish with the material before drying

W_2 = weight in g of the dish with material after drying

Determination of Ash Content of *Rigatoni* pasta

The ash content in the sample was estimated according to AOAC (1990).

Procedure

About 5 g of the powder sample were accurately weight into a pre-weighed silica crucible. It was then carbonized in silica crucible on burner followed by heating at about 600 °C for 6 h. In the muffle furnace to get complete white it was cooled in the furnace. Then the crucible was transferred to desiccators and weighed as possible to prevent moisture absorption. Ash content was determined using Formula 2

$$\text{Ash content (\%)} = \frac{\text{Weight of crucible after ash–Weight of empty crucible}}{\text{Total weight of sample}} \times 100 \quad .. (2)$$

Determination of Protein Content of *Rigatoni* pasta

The Micro kjeldahl method described by AOAC (1984) was used to determine the protein content. Two g of each of the samples were mixed with 10ml of concentrated H_2SO_4 in a heating tube. 2-3g of catalyst mixture was added to the tube and the mixture was heated inside a fume cupboard. The digest was transferred into distilled water. 10 ml portion of the digest mixed with equal volume of 40% NaOH solution was taken and poured into a micro kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 2% boric acid solution containing Bromocresol green and methyl red indicator in the ratio of 1:5. A total of 50 ml distillate was collected and titrated. The sample was duplicated and the average value was taken. The Nitrogen content was calculated and multiplied with 6.25 to obtain the protein content. Protein content was determined using formula 3

$$\text{Nitrogen (\%)} = \frac{(100 \times N \times 14 \times VF)T}{100 \times Va} \quad .. (3)$$

$$\text{Protein (\%)} = \text{Nitrogen (\%)} \times 6.25$$

Where
N= Normality of the titrate (0.1N)
VF= Total volume of the digest= 100ml
T= Titre Value
VA = Aliquot Volume distilled

Determination of Fat Content of *Rigatoni* pasta

The fat content was determined by the ether extraction using Soxhlet's apparatus. Reagent Petroleum ether having a boiling point of 40-60 °C was used. Five g of grinded moisturized sample was weighed accurately in thimble and defatted with petroleum ether in Soxhlet apparatus for 6-8 h at 60°C. The resultant ether extract was evaporated and the lipid content was calculated (AOAC, 1984) as given in equation 4

$$\text{Fat (\%)} = \frac{W_2 - W_1}{W_3} \times 100 \quad .. (4)$$

Where
W_1 = weight of the empty extraction flask
W_2 = weight of the flask and oil extracted
W_3 = weight of the sample

Soluble/ insoluble Dietary Fiber Determination

Insoluble dietary fiber (IDF) was filtered, and then residue was washed with warm distilled water. Combined solution of filtrate and water washings were precipitated with 4 volumes of 95% ethanol (EtOH) for soluble dietary fiber (SDF) determination. Precipitate was then filtered and dried. Both SDF and IDF residues were corrected for protein, ash and blank, for the final calculation of SDF and IDF values AOAC (2011).

Total Dietary Fiber

SDF (Soluble dietary fiber) was precipitated with EtOH (Ethyl alcohol) and residue was then filtered, dried and weighed. Total dietary fiber (TDF) value was corrected for protein and ash content AOAC (2011).

Statistical Analysis

Unless otherwise mentioned, each analysis had been done in triplicate. One-way analysis of variance (ANOVA) was used to determine statistical significance, and results were reported as the mean standard deviation.

RESULTS AND DISCUSSION

The physico-chemical proportions of foods ultimately impact their sensory attributes, behaviour during manufacture, storage, and consumption, and perceived quality. Food processing is necessary to extend the shelf life of the product as well as to change its physicochemical composition and structural composition, which may or may not be advantageous. The physicochemical characteristics of the food play a major role in determining the final product's quality. The amount of moisture, fat, ash, protein, soluble and insoluble fibre, total dietary fibre, and colour of the rigatoni pasta are all included in this feature. Table 1 shows the physico-chemical properties of *Rigatoni* Pasta.

Table 1. Physico-chemical properties of *Rigatoni* pasta

Treatments	Moisture content (%)	Fat content (%)	Ash content (%)	Protein content (%)	Soluble fibre (%)	Insoluble fibre (%)	Total dietary fibre (%)
T0	4.96±0.2	5.28±0.1	2.97±0.6	19.06±0.1	1.51±0.1	5.02±0.8	7.02±0.2
T00	4.36±0.1	1.08±0.1	2.03±0.2	10.13±0.3	1.53±0.2	4.52±0.8	5.22±0.1
T1	4.25±0.2	3.32±0.2	1.99±0.1	17.84±0.2	1.54±0.1	5.21±0.2	6.58±0.1
T2	4.03±0.1	3.19±0.1	2.02±0.3	14.33±0.1	1.57±0.2	5.62±0.1	7.01±0.2
T3	4.02±0.1	2.91±0.2	2.04±0.2	13.68±0.2	1.62±0.1	6.51±0.2	8.32±0.5
T4	3.99±0.1	2.71±0.1	2.08±0.1	12.87±0.2	1.68±0.1	7.97±0.1	8.93±0.2

Moisture content of *Rigatoni* Pasta

Any amount of water contained in a food product is considered to be its moisture content. A crucial factor in regulating the shelf life of food products is the moisture levels. The product's hygroscopicity or hydrophobicity, the permeability of the packaging material and storage ambient conditions like temperature variations and relative humidity all affect how much moisture is absorbed (Gull *et al.,* 2017). According to Table 1, the moisture content in T00 (Rice) is high which is 4.96, as well as in sample T1 which is 4.25 and in sample T4 was lowest 3.99. The moisture content of T1, T2, T3 and T4 is 4.25, 4.03, 4.02 and 3.99 respectively. It could be observed that the moisture content of *Rigatoni* Pasta decreased when the level of raw banana powder in the *Rigatoni* Pasta increased as described by Ovando-Martinez *et al.,* (2009). A similar trend was found by Pacheco-Delahaye (2001), who reported that when the product's level of banana flour increased, the moisture content decreased. The shelf-life of food products depends on the amount of moisture in the product. Raw banana flour has a low moisture level, similar to that found in commercially available dry products like wheat germ, oat biscuits, and bran flakes stated by Garcia *et al.,* (2006).

Fat content of *Rigatoni* Pasta

A source of vital fatty acids that the body cannot generate on its own, fat is an important component in the diet. Fat helps in the body's intake of vitamins A, D, and E. These vitamins are only absorbed with the help of lipids because they are fat-soluble.

The fat content of rice flour and amaranth flour was 1.08%, 5.28% respectively according to Table 1, Amaranth flour has highest fat content (5.28) compared with rice and raw banana flour. Most of the fats in amaranth grain flour are unsaturated fats, including linoleic and alpha linolenic fatty acids (Soriano and Saraid, 2019). Fat content of all the treatments such as T0, T00, T1, T2, T3 and T4 are 5.28%, 1.08%, 3.32%, 3.19%, 2.91% and 2.71% respectively. The fat content was highest in sample T1 and lowest in T4. The results found that the fat content of all treatments decreased with the addition of raw banana flour in the formulations.

The raw banana flour was plainly substituted for the amaranth and rice flour. Consequently, as the amaranth concentration declined, so did the fat content of all treatments. Amaranth grain has a higher fat content than the majority of commonly consumed grains, including rice, wheat and maize (Mekonnen *et al.,* 2018). The same effects of relationship of fat content with amaranth based pasta product were found in Perez *et al.,* (2022) and Emire and Arega (2012). Similar results were also found in Rosa *et al.,* (2015), which stated that the fat content increased when amaranth flour was added because it has an excellent fatty acid profile and contains about six times much more fat as rice and raw banana flour.

Ash content of *Rigatoni* Pasta

The whole nutritional value, quality, and stability of the food can be determined by determining the ash content of the food. When a food sample is described as having an "ash content," it refers to the minerals and organics that are still present after the sample has been heated to a very high temperature, which removes moisture, volatiles, and organics. The pericarp, which remains with the grain after milling, is the reason of the amaranth-containing pastas' increased ash level (Rubio *et al.,* 2014).

According to Table 1, the ash content in T00 (Amaranth) sample was highest 2.97. But as per study the ash content is increasing with the addition of Raw banana flour, so the highest ash content was in sample T4 of *Rigatoni* (pasta) and lowest was in sample T1. The ash content of T1, T2, T3 and T4 sample was 1.99, 2.02, 2.04 and 2.08 respectively.

Ash content increased when the banana flour amount in the noodles increased. As per Kim, (1996) ash content is affected by flour quality and consequently reflects increased mineral content, particularly potassium. High levels of potassium (400 mg/100 g pulp) and magnesium (34 mg/100 g edible part contents) are present in bananas (McCance and Widdowson, 2002). As per the investigation on pasta reported by Shevkani *et al.,* (2014) and Alonso-Miravalles and O'Mahony (2018) these findings are consistent with those and revealed that ash content of amaranth was 3.2% and 2.4%, respectively. Alonso-Miravalles and O'Mahony (2018) also evaluated buckwheat (1.51%), which is almost in line with the current findings with low ash concentration. The other flours were found to be considerably different from one another at a 5% level, with the exception of wheat flour and unripe banana flour. The usage of whole flours, which contain the outer husk, which is a rich source of minerals, may be one factor contributing to the high ash level (Lopera-Cardona *et al.,* 2016).

Protein content of *Rigatoni* Pasta

Almost all proteins with the exception of storage proteins are essential for biological processes and cell structure. Proteins are a plentiful component of all cells. The majority of food reference values used to calculate protein content is 100 g (for solids) or 100 ml (for liquids), 100 kcal. The quantity of food has a direct relationship with its protein content; so, as the quantity of food changes, its protein content also changes for the better or worse (Forouzesh *et al.,* 2022). According to Table 1, the highest protein is in sample T0 and in T1 which is 19.06 and 17.84 respectively. Sample T4 contained 12.87 which was lowest protein content. The protein content in remaining sample was 10.13, 14.33 and 13.68 for T00, T2 and T3 respectively. The reduction in the network created by gluten and the increase in banana flour content in the noodles, which results in a lower protein content (Ritthiruangdej *et al.,* 2011). Rustagi *et al.,* (2022) studied and evaluated the protein content of wheat and amaranth flours and discovered similar findings. Physico-chemical and functional changes of unripe banana may be too responsible for the low protein content of banana flour. Shevkani *et al.,* (2014) in their study reported thatthe protein content was found from range 12.3 to 16.7% among its various types, according to research that highlighted the physiochemical properties of full-fatted and defatted amaranth flours. Amaranth protein is considered to be useful for both healthy and ill people since it is rich in amino acids, particularly lysine, which the lack in other cereal grains. The requirement for composite/gluten-free formulations is justified by the protein concentration of flours other than wheat.

Fiber content of *Rigatoni* Pasta

Diets high in fibre, such those made up of grains, nuts, fruits, and vegetables, are good for health because they've been linked to a lower incidence of a number of diseases. Different processing methods, such as extrusion cooking, canning, grinding, boiling, and frying, among others, have an impact on dietary fiber's physicochemical properties and enhance their functionality (Dhingra *et al.,* 2012). In recent years, the main importance of fibers has to create potential market for the development of food products rich in fiber with new trends.

According to Table 1, the fiber content of sample T0 (amaranth) and T00 (rice) were 5.2% and 7.02% respectively. Amaranth is an excellent source of high soluble fiber. It has 1.51% of soluble fiber and 5.02% of insoluble fiber. In the composite flour blend treatments from T1 to T4, fiber content increased. The watersoluble fibre includes mucilages, pectin, and gums (Anita and Abraham, 1997). The soluble fiber content of treatments T1, T2, T3 and T4 were 1.54%, 1.57%, 1.62% and 1.68% respectively. An insoluble fiber includes cellulose, hemicellulose and lignins (Anita and Abraham, 1997). Treatments T1, T2, T3 and T4 had increased insoluble fiber from T1 to T4 as 5.21%, 5.62%, 6.51% and 7.97% respectively. Therefore the total dietary fiber also increased with increasing the amount of raw banana flour addition from sample T1 to T4. The treatments T1, T2, T3 and T4 had 6.58, 7.01, 8.32 and 8.93 percent of total dietary fiber respectively.

The significant amount of dietary fibre found in raw banana powder makes it a rich source of fibre. It has a fibre level of 15.40% (Bezerra *et al.,* 2013)**.** Therefore as the amount of raw banana flour content increased by replacing with rice and amaranth flour, the fiber content of the composite flour blend also increased. The raw banana powder has a higher level of insoluble and soluble minerals than other flours, which explains for its higher contents (Pereira *et al.,* 2013; Bezerra *et al.,* 2013).

CONCLUSION

The evaluation of physicochemical properties of

pasta, it was observed that the total dietary fiber content were increased after infusion of raw banana flour content which makes it fiber rich pasta. The protein content decreased slightly after addition of RBF, still the pasta had the good protein content. The raw banana flour incorporated pasta was rich in fiber content as both the amaranth and raw banana powder have good content of dietary fibers. Sample T2 of moisture content, fat, Ash, Protein, soluble, insoluble and total dietary fibre, i.e. 4.03, 3.19, 2.02, 14.33, 1.57, 5.62 and 7.01 % respectively, which gives the better quality and also more acceptable in terms of taste.

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