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FULL LENGTH ARTICLE

Nutritional, antioxidant, microstructural and pasting properties of functional pasta

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Abstract The present study aimed to characterize millet-pomace based pasta on the basis of functional, morphological, pasting and nutritional properties with control pasta (100% durum semolina). Functional pasta was developed by using blend of 20% finger millet flour, 12% pearl millet flour, 4% carboxy methyl cellulose (CMC) and 64% composite flour containing durum semolina and carrot pomace. Nutritional analysis of developed pasta showed high content of minerals viz calcium, iron, zinc and dietary fiber compared to control pasta. The developed pasta showed better quality characteristics in terms of cooked weight, swelling index and water absorption. Color evaluation of developed pasta showed increase in L^* and b^* values. Phenolic content and antioxidant activity of developed pasta was significantly higher with respect to control. Also significant ($p < 0.05$) variations were observed in pasting properties between pasta samples. Microstructure evaluation of cooked pasta showed better interaction between starch and protein matrix with addition of carboxy methyl cellulose gum.

1. Introduction

Pasta products are most popular foods. These are normally high in starch but low in dietary fiber, minerals, vitamins and phenolic compounds. In order to enhance nutritional value of pasta several studies have focused on possibility of adding functional ingredients into pasta (Bustos et al., 2013; Fiorda et al., 2013). Millets are rich in phytochemicals which exhibit antioxidant and free-radical scavenging activity. These have been shown to impart antimutagenic, antiglycemic and antioxidative properties (Dykes and Rooney, 2006). As these are also "gluten-free" it could be suitable for persons suffering from celiac disease (gluten intolerance). Having several health benefits there is great interest for millets among scientists in their use for different food formulations. Pearl millet (*Pennisetum typhoideum*) is one of the most important drought tolerant crops cultivated mostly in semi-arid parts of Africa and Asia. Besides being rich in iron, calcium, zinc, it is nutritionally comparable and even superior to major cereals due to its energy and protein value (Sehgal and Kwatra, 2006; Malik et al.,

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2002). Finger millet (*Eleusine coracana*) is widely grown minor millet in the world. It is a rich source of calcium and dietary fiber. Its seed coat is an edible component of kernel and rich source of phytochemicals such as polyphenols. It can be used both in the native and in the processed forms (Rao and Muralikrishna, 2001). Carrot (*Daucus carota*) is an excellent source of calcium pectate (pectin fiber). Its pomace is a natural source of α-carotene and β-carotene. Besides this carrot pomace is having good residual amount of vitamins, minerals and dietary fiber. Incorporation of pomace into extruded products could provide dietary fiber source. Also addition of dietary fiber can reduce the glycemic index of pasta and introduce additional health benefits. With an increasing concern by health conscious people more nutritious pasta products rich in minerals, phenolic compounds and dietary fiber with low glycemic index have become the subject of primary significance. In our previous study it was observed that incorporation of millet flours and carrot pomace into pasta at higher levels does not show better pasta cooking quality characteristics, so there is need of addition of hydrocolloid. Thus the present study aimed to develop functional pasta from blends of millet flours and carrot pomace and to study the quality characteristics of developed functional pasta.

2. Material and methods

Durum wheat semolina was procured from Goyal Wheat Milling Industries, Indore (India). Finger millet and Pearl millet grains (HHB-67) were obtained from Shimla (India) and Hisar (India). Finger and pearl millet flour and carrot pomace were prepared as per method used by Gull et al. (2015a). Carboxy methyl cellulose was procured from Loba Chemie Pvt. Ltd. (Mumbai). All the chemicals used for analysis were of analytical grade.

2.1. Preparation of pasta

From the previous experiments of Gull et al. (2015b) results not shown here, blend of 20 g FMF and 12 g PMF 100 g^{-1} to composite flour (96 g durum wheat semolina: 4 g carrot pomace) was optimized. The optimized formulation was added with hydrocolloid such as carboxy methyl cellulose (4 g.–100 g^{-1}) to improve the quality of developed pasta. Blend of different flours was mixed in Hobart mixer (model 5KPM50, USA) at low speed (set 1) with optimal (34.71 ml) water for 12–15 min. Finally premixed dough was extruded using pasta machine with single screw (Model: Dolly La Monferrina, Italy) fitted with an adjustable die. Finally extruded pasta was dried at 60 °C for about 3 h. The resultant dried pasta was packed in Low density polyethylene (LDPE) bags kept in refrigerator for further analysis.

2.2. Proximate and mineral analysis of pasta sample

Moisture, protein, fat and ash contents of pasta samples were determined using AACC method (2000). Carbohydrate was calculated by subtracting the sum of moisture, protein, fat and ash from 100. Minerals were determined using the method of Chapman and Pratt (1982). Total dietary fiber content was analyzed by using the method of IS-11062 (1984). Carotene content was determined by using the method of Ranganna (1986).

2.3. Cooking characteristics of pasta

Cooking quality characteristics of pasta viz, cooking loss and cooked weight were determined according to AACC approved method (2000).

2.4. Swelling index and water absorption

Swelling index and water absorption of cooked pasta were measured by using the method described by Tudorica et al. (2002).

Swelling index of cooked pasta (g of water per g of dry pasta) was evaluated by drying pasta samples to constant weight at 105 °C and expressed as follows:

$$\frac{\text{Weight of cooked product} - \text{weight after drying}}{\text{weight after drying}} \quad (1)$$

Water absorption of drained pasta was determined as follows:

$$\frac{\text{weight of cooked pasta} - \text{weight of raw pasta}}{\text{weight of raw pasta}} \times 100 \quad (2)$$

2.5. Pasta firmness

The firmness of cooked pasta samples was measured by using a Texture Analyzer model (TA-XT2., Stable Micro systems, UK). Three cooked pasta strands were sheared at a 90° angle. The shear was performed using a probe (75 mm diameter) at a crosshead speed of 50 mm/min and load cell 50 N. The force required to shear the pasta was measured.

2.6. Extraction and determination of total phenolics content and antioxidant activity

Samples were extracted using the method of Abu Bakar et al. (2009) with slight modification. Briefly 2 g raw and 5 g cooked pasta were extracted for 2 h with 10 ml of 80% methanol at 28 °C on an orbital shaker set at 180 rpm. The mixture was centrifuged (Rota 4R-V/Fm) at 1400 g for 20 min and the supernatant was decanted. The sediment was re-extracted under identical conditions. The supernatant was combined and used for the total antioxidant activity and total phenolics.

Antioxidant activity was measured using the method described by Brand-Williams et al. (1995). The supernatant 0.1 ml was reacted with 3.9 ml of a 6×10^{-5} mol/l of DPPH solution. The absorbance at 515 nm was read at 0 and 30 min using a methanol blank. The antioxidant activity was calculated as % discoloration:

$$\left\{1 - \left[\frac{\text{A of sample } t = 30}{\text{A of control } t = 0}\right]\right\} \times 100 \quad (3)$$

The total phenolic content (TPC) was determined by Folin–Ciocalteu spectrophotometric method as described by Sharma and Gujral (2010). About 0.15 ml Folin–Ciocalteu reagent was added to the extract (0.3 ml of aliquot). The mixture was set aside to equilibrate for 5 min and then mixed with 0.3 ml of 7% sodium carbonate. Subsequent incubation was at 25 °C temperature for 90 min, and the absorbance of the mixture