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Utilisation of pigeon pea (*Cajanus cajan* L) byproducts in biscuit manufacture

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ABSTRACT

Biscuits were prepared by substituting wheat flour with dehulled pigeon pea (*Cajanus cajan* L) flour (PPDF) or pigeon pea byproduct flour (PPBF). PPBF was obtained by recovering edible cotyledon material from milling byproducts. PPBF had a higher level of protein (29.42 g/100g) compared to PPDF (24.67 g/100g). Composite flour blends were prepared by substituting wheat flour (WF) with either PPDF or PPBF at 95:5, 90:10, 85:15, 80:20 and 75:25 incorporation levels. Biscuits were analysed for composition, physical and sensory parameters. Protein content of PPDF and PPBF fortified biscuits increased by 1.3 and 1.4 times respectively compared to control along with a significant increased in fibre content. Results indicate that good quality biscuits with increased levels of protein and fibre can be prepared by substituting wheat flour using 85:15 of PPDF or 90:10 of PPBF without significantly affecting the sensory quality of biscuits. This study demonstrates the potential feasibility of incorporating pigeon pea milling byproducts in the manufacture of biscuits.

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1. Introduction

Legumes have been widely recognized as important source for supplementing cereal based traditional bakery products such as biscuits, cookies and bread (Patel & Rao, 1995). Cereal based bakery foods are formulated with protein sources such as milk or legumes flour to improve nutritional quality (Adeyemi, Komolafe, & Akindele, 1989). Improvement of the nutritional quality of cereal based snack foods through fortification with other leguminous or animal proteins has been investigated in several studies (Blandino, Al-Aseeri, Pandiella, Cantero, & Webb, 2003; Kerr, Ward, McWatters, & Resurreccion, 2001; Ranjana, Singh, & Chuhan, 2000; Rao & Surpalekar, 1996). Defatted soy flour has been widely used to improve the nutritional quality of cereal based products (Singh, Singh, & Chauhan, 1996). Fortification of biscuits using chickpea and broad bean flours as well as isolated soy protein isolates has been reported (Rababah, Al-Mahasneh, & Ereifej, 2006). Use of legumes flour as a source of protein in bakery products has also been reported (Cady, Carter, Kayne, Zabik, & Uebersax, 1987; Eneche, 1999; Hegazy & Faheid, 1990; Mustafa, Al-Wessali, Al-Basa, & Al-Amir, 1986; Sathe, Iyer, & Salunkhe, 1981; Lorenz, 1983). Literature review reveals that in general the nutritional, physical and sensory characteristic of biscuits depends on both the physicochemical properties of the legumes used in the formulation and on processing method employed for preparation of the legume flour.

Pigeon pea (*Cajanus cajan* L) grain has potential value as an economic source of protein and is widely consumed after appropriate processing. Dehulling is the most commonly followed processing method. It is estimated that about 2.5 million tonnes of byproducts are generated annually from legume processing industries in India. Byproducts comprise of hull, powder, brokens, shrivelled and under- processed grain. Typically byproducts account for approximately 20–30% of total grains processed depending upon the machinery and other processing factors (Narasimha, Ramakrishnaiah, Pratape, & Sasikala, 2004). Brokens and powder obtained from pulse milling is generally used as cattle feed. However legume milling byproducts have potential use in human nutrition. In the present study, the objective was to investigate the potential of pigeon pea byproducts for the fortification of biscuits.

2. Material & methods

Commercial refined wheat flour (Anapurna Co.) was purchased from a local supermarket (Punniamoorthi Department store, Thanjavur, Tamil Nadu, India). Pigeon pea grains were purchased from local market (Armugam Nadar & Sons, Thanajvur, Tamil Nadu, India). Pigeon pea was subjected to dehulling as outlined by (Kurien & Ramakrishna, 1985). Byproducts such as brokens, powder and husk were separated as per the procedure of (Narasimha et al., 2004).

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2.1. Preparation of flour

Dehulled pigeon pea splits obtained after dehulling were subjected to milling in a vertical plate grinder (AMI engineering, Patna, India) to obtain fine (250 μm, British standard sieve) pigeon pea flour (PPDF). Edible cotyledon materials of different sizes recovered from milling byproducts were subjected to milling in vertical plate grinder (AMI engineering, Patna, India) to obtain pigeon pea byproduct flour (PPBF).

2.2. Composition of biscuit flour

Blends of PPDF or PPBF with refined wheat flours were prepared by combinations of 95:5, 90:10, 85:15, 80:20 and 75:25 of refined wheat flour with PPDF or PPBF.

2.3. Preparation of biscuits

Biscuits were prepared from composite flours of wheat flour (WF), PPDF or PPBF and other ingredients such as shortenings, sugar, salt and sodium bicarbonate (Table 1). Ingredients were weighed using an electronic balance (Model CP43S, Sartorious, Germany). Composite flours and other dry ingredients (sodium bicarbonate, sugar and salt) were mixed together in a bowl and shortenings were added. Mixing was carried out in a Hobart mixer for 3–5 min to obtain a creamy dough. The specified amount of water was added gradually during continuous mixing until a slightly firm dough was obtained. A total of ca 15 baked biscuits each weighing approximately 17.4 ± 1.02 g were obtained for each of the recipe. Kneaded dough was manually rolled into sheets of required thickness and cut into round shapes using a biscuit cutter of 5 cm diameter cm and 1 cm height. Biscuits were baked in batches at 180 ± 2.0 °C for 20 min. Baked biscuits were cooled to room temperature (25 ± 1.0 °C) and packed in polyethylene bags until analysis.

2.4. Proximate composition

Moisture content, total ash and crude fat of flour and biscuits were determined (AACC, 1995). Crude protein was determined using the Kjeldahl method and total carbohydrate was obtained by difference method.

2.5. Evaluation of biscuits

Physical properties of biscuits such as of diameter, thickness, weight, volume and spread factor were determined (AACC, 1995). Diameter and thickness of biscuits was measured using a Vernier calliper (Mitiyoto Co. Tokyo, Japan). Average values of 4 biscuits were recorded. Biscuits were evaluated by a panel of 6 trained judges as per the score sheet of Hoojjat and Zabik (1984). Panelist consisted of both male (2) and female (4) in the age group of 21–55. The biscuits were evaluated based on shape, surface colour, and surface characteristics, interior appearance of the distribution of gas cells, crumb colour and eating qualities of texture, mouthfeel and flavour. The score assigned were 7, 4, and 1 for excellent, satisfactory and very poor qualities respectively (Patel & Rao, 1995). The overall score was determined by summing the score for each characteristic and calculating the average. Hardness of the biscuits was measured as per the procedure of Patel & Rao (1995) using TA XT plus Texture analyser (Stable Microsystems Ltd, Surrey, UK).

Table 1
Ingredients used in biscuit preparation.

Ingredients	Quantity (g)
Composite flour	100.0
Sugar	53.0
Shortenings	26.5
Glucose	1.0
Salt	1.0
Sodium bicarbonate	1.0
Water	Variable 15–20 mL (dough consistency)

2.6. Statistical analysis

All experiments were carried out in triplicate unless otherwise mentioned and average values were reported. Experimental data obtained was statistically analysed using statistical software (SAS V.9.1, SAS Institute, NC, USA). Means were separated by least significant difference (LSD) using Tukeys test. Significance was accepted at $p < 0.05$.

3. Results & discussion

During preparation of biscuits, it was observed that all 5 formulations with PPDF and PPBF had good dough handling characteristics except for composite flour with 75:25 PPBF incorporation level. Dough handling, sheeting and cutting was good for all formulations. Fig. 1 shows the biscuits prepared from composite flours.

3.1. Nutritional composition of flours

Proximate composition of refined wheat flour, PPBF and PPDF is given in Table 2. Data presented shows that PPBF had a considerably higher protein content (29.42 g/100g) than the PPDF (24.67 g/100g) and WF (11.45 g/100g). The crude fat (5.73 g/100g), crude fibre (4.66 g/100g) and total ash (5.32 g/100g) content of PPBF was higher than PPDF and WF. The higher protein content and ash content in PPBF is because the outer layers of cotyledons in pigeon pea grains which are removed during pitting and milling contain higher amounts of protein, minerals and trace elements (Singh, Rao, Seetha, & Jambunathan, 1989; Tiwari, JaganMohan, & Vasan, 2007). Considerable amounts of protein and minerals are lost as byproducts which are usually in the form of powder, dehulled or unhulled broken grains and fibre rich fractions. The higher amount of protein, fat and ash in PPDF is due to the presence of fibre rich fractions from the hull and powder generated during abrasive dehulling of pigeon pea grains during processing. Hull in pigeon pea is reported to contain higher amount of minerals than cotyledons. Higher crude fat content in byproduct flour is due to presence of oil rich germ, which is removed during dehulling of pigeon pea grains. The nutritive value of PPBF, PPDF and WF are similar to the findings of Gopalan, Ramasastri, and Balasubramanian (1982).

3.2. Nutritional composition of biscuits

The nutritional composition of biscuits prepared from composite flour of WF + PPDF and WF + PPBF is shown in Table 3. It is indicated from Table 3 that incorporation of PPDF and PPBF resulted in favourable proportions of protein, fat and ash. Moisture content varied from 4.14 to 4.81 g/100g and 4.14–4.79 g/100g for biscuits prepared with increasing amounts of PPDF and PPBF, respectively. Protein content of biscuits prepared from composite flour of WF and PPDF ranged from 6.21 to 8.00 g/100g and from 6.21 to 8.64 g/100g for biscuits prepared from WF and PPBF. These findings are in agreement with previous studies conducted by Ory and Conkerton (1983) on supplementation of bakery foods with high protein peanut flour and Singh et al. (1996) on incorporation of defatted soyabean flour for preparation of biscuits. Eneche (1999) also

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