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Chickpea flour supplemented high protein composite formulation for flatbreads: Effect of packaging materials and storage temperature on the ready mix

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ABSTRACT

Shelf life studies are gaining impetus due to the consumer's attentiveness towards excellence of the packaged products. The present study was carried out to develop a composite premix formulation for chickpea supplemented flatbread and to estimate the suitability of packaging material and storage temperature on its quality. Whole wheat flour was supplemented with chickpea flour from 10 to 50%; fenugreek powder and onion flakes at 0–20%; salt, ginger powder, green chilli powder and red chilli powder at 0–2%, mango powder at 0–5%; glycerol mono stearate (GMS) and sodium steaoryl-2-lactylate (SSL) at 0–0.50% and fat at 0–4%. Two formulations (I and II) were prepared after selecting the appropriate levels of ingredients by sensory evaluation using trial and error method. Formulations were packed in zip pouch, aluminum laminate and high density poly ethylene at room and refrigeration temperatures. Changes in the total composition, water activity, free fatty acid, overall acceptability and texture of flatbreads were assessed for four months. Storage period had most significant effect followed by storage temperature and packaging material on quality attributes of formulations. All the samples were in acceptable condition where aluminum laminate and refrigerated temperature were the best combination for storage of formulation I and II.

1. Introduction

Early human society embraced cereal grains as dietary source and flatbreads, baked cereal products, were among the first ever cooked products prepared by ancient civilizations. Across the globe, flatbreads are arguably the most consumed category of breads. As a food staple, it has been estimated that 1.5 billion people consume traditional flat breads (Quail, 2016). Flatbreads are extensively prepared using wheat (*Triticum aestivum*) flour. Several modifications in the formulations have been made in the recent past in order to improve the quality and delicacy of these food products. In India, wheat is one of the daily staples, consumed in the form of different flat breads such as *Chapati, Parotha, Phulka, Puri* and *Tandoori Roti* (Saxena, Salimath, & Rao, 2000). Approximately 85–90% wheat flour is widely consumed in the form of *chapati* in India, and is the staple diet of 60% of the population (Gocmen, Inkaya & Aydin, 2009; Yadav, Singh, & Rehal, 2012). It is a good source of calories and other nutrients, however, lysine has been reported to be the most limiting amino acid (Dhingra & Jood, 2001; Quail, 2016). Addition of legume flour to wheat flour based baked products improves essential amino acid balance of such foods (Mohammed, Ahmed, & Senge, 2012). The derived flours are termed as composite flours which are a mixture of flours from tubers rich in starch (Cassava, sweet potato) and/or protein rice flours (soy, peanut) and/or cereals (rice, maize) with, or without wheat flour (Seibel, 2011; Noorfarahzilah, Sharifudin, Mohammad, & Hasmadi, 2014). Among the legume protein products, soybean protein preparations (Ribotta, Arnulphi, Leon, & Anon, 2005), chickpea flour (Gomez, Oliete, Rosell, Pando, & Fernandez, 2008), germinated chickpea flour (Fernandez & Berry, 1989) and germinated pea flour (Sadowska, Blaszczak, Fornal, Vidal-Valverde, & Frias, 2003) have been studied for supplementation.

Chickpea (*Cicer arietinum*) is nutritionally important as a source of proteins, vitamins and minerals in the daily diets of the people of Indian Sub-continent. Addition of chickpea flour to wheat flour gives slightly yellowish colour to flatbread which is highly relished by Indian consumers. The functional properties of chickpea protein provide good baking characteristics in wheat breads elaborated with chickpea flour (Mohammed et al., 2012). Along with chickpea flour, addition of food ingredients from other plant sources

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improves overall nutritive quality. Such efforts not only extend dietary improvements but will eliminate the problem of single nutrient deficiency and would also be protective against other nutritional deficiencies and provide antioxidants (Reema, Heera, & Sadana, 2004).

Many countries, including India, have traditional foods which are nutritionally better than common wheat bread. The concept has been derived from *Missi roti* which is traditional unleavened single layered bread baked on hot plate, prepared after incorporating chickpea flour in whole wheat flour with many functional ingredients viz fenugreek (Sharma & Chauhan 2000), onion (Gupta & Garg 2006), ginger, mango powder, green chillies, red chilli powder (Berry 2003); is gaining popularity due its nutritional balance and high satiety value.

Freshly baked flatbreads are soft and elastic. They stale within few hours and become hard and tough at room temperature and are difficult to chew (Shalini & Laxmi, 2007). Hence, it is imperative to bake them fresh and hence increases the importance of ready mixes which are flavorful and nutrient dense. It is a well-known that the storage stability of food systems depends on the storage conditions and information on the influence of storage conditions on quality of composite flours is scarce in literature. In this study, premix mixture contain non perishable and required constituents of the recipe for baked product. The objective of this study was to develop a commercially feasible formulation for flatbread and to study the effect of packaging material and storage temperature on shelf life of the premix.

2. Materials and methods

2.1. Materials

Whole wheat flour (*Triticum aestivum*) and chickpea flour (*Cicer arietinum*) were procured from the local market in Ludhiana, Punjab, India. Fresh fenugreek (*Trigonella foenum-graecum*), onion (*Allium cepa*), green chilli (*Capsicum annuum*), ginger (*Zingiber officinale*), red chilli powder (*Capsicum annuum*), mango powder (*Mangifera indica*) were purchased from the vegetable market. Salt (Tata), glycerol mono stearate (GMS) and sodium steaoryl-2-lactylate (SSL) and pure milk fat (*Ghee*) were purchased from the local market. Zip Pouches (200 gauge), aluminum laminates (500 gauge) and high density polyethylene (500 gauge) were obtained from local market.

2.2. Preparation of ingredients

2.2.1. Preparation of fenugreek powder

Fresh fenugreek leaves were cut from the stem in order to make them free of soil and dirt. The leaves were washed with ample of fresh and clean water number of times. The stalks were removed carefully to obtain fenugreek leaves. The leaves were then blanched for 2 min and air dried to remove any residual moisture (Navale, Supriya, Harpale & Mohite, 2014). The leaves were laid on the tray and dried for 4 h at 60 °C (Satwase, Pandhre, Sirsat, & Wade, 2013). The dried leaves were ground and powder was passed through 36 BSS sieve.

2.2.2. Preparation of onion flakes

The onion bulbs were thoroughly cleaned to remove any dirt or dust particles attached to the surface. The cleaned onions were peeled and the roots were cut with a sharp stainless steel knife. Onions were sliced using an onion slicer into slices of 2 to 5 mm thickness. Onion slices were dried for 15 h at 50 °C in a cabinet drier (Gouda, Ramachandra, & Nidoni, 2014). Due to the high amount of reducing sugars which leads to hygroscopic nature of onion powders, flakes were preferred for developing the formulation.

2.2.3. Preparation of ginger powder

Freshly harvested gingers were properly washed in fresh running water. Ginger rhizomes were peeled manually and cut into slices of 1.5–2 mm thickness by a slicing machine. The sliced ginger was spread uniformly in a thin layer on to the trays and dried for 6 h at 55 °C in a cabinet drier (Loha, Das Choudhary, & Chatterjee, 2012). The dried ginger was ground and passed through 36 BSS sieve.

2.2.4. Preparation of green chilli powder

Fresh green chillies were washed and stalk was removed. The chillies were fan dried to remove excess water from washing. It was dried for 12 h in a cabinet drier at 65 °C (Chaethong, Tunnarut & Pongsawatmanit, 2012). The dried sample was ground and passed through 36 BSS sieve.

2.3. Standardization of formulation for flatbread

Whole wheat flour was supplemented with chickpea flour from 10 to 50%; fenugreek powder and onion flakes at 0–20%; salt, ginger powder, green chilli powder and red chilli powder at 0–2.0%; mango powder at 0–5.0%; GMS and SSL at 0–0.50% and fat at 0–4.0%. Level of each ingredient was selected on the basis of flatbread quality and overall acceptability of the product assessed by a panel of ten semi trained panelists of food technologists, technicians and post graduate students. Formulation was prepared after adding all the ingredients in optimum proportion for preparation of flatbread.

2.4. Preparation of flatbread

The ingredients were mixed and water was added in optimum quantity for each sample. The samples were mixed in a laboratory 3-pin mixer (National manufacturing company, Lincoln, USA). The dough was allowed to rest for 15 min and divided into 40 g pieces. Each dough piece was formed into spherical shape and manually rolled into circular form of about 150 mm diameter using rolling pin. The circular dough sheets were baked on a hot plate at 230 ± 5 °C for 1–2 min on either side (Yadav, Rajan, Sharma, & Bawa, 2010).

2.5. Sensory studies

Milk fat (*Ghee*) was applied on one side of the flatbread. Sensory quality was evaluated by panel of minimum ten semi trained judges on nine point hedonic scale for appearance, hand feel, colour, flexibility, eating quality and overall acceptability (Figs. 1 and 2).

2.6. Preparation and storage of formulations

The proportions of ingredients in the final formulations were finalized after standardization of each ingredient by trial and error method. The formulation I (1000 g) had 411 g whole wheat flour, 411 g chickpea flour, 16.5 g salt, 41 g fenugreek powder, 8.0 g ginger powder, 82 g onion flakes, 4.0 g green chilli powder, 4.0 g red chilli powder, 16.5 g mango powder, 2.5 g GMS and 2.5 g SSL. The formulation II had additional 20 g of milk fat (Ghee) in the same recipe of formulation I.

All the ingredients were mixed thoroughly to obtain a homogenous blend. Zip Pouches (ZP), aluminum laminates pouches (AP) and high density polyethylene (HDPE) was used for the packaging of formulations (200 g/pack). Oxygen permeability (OTR in $cm^3/m^2/24$ h at 38 °C and 90% RH) was 12.80, 8.00 and 7.50 for zip pouches, aluminum laminates pouches and high density poly ethylene respectively. Water vapor transmission rate