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Nutritional assessment of cookies supplemented with defatted wheat germ

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Abstract

Replacement of wheat flour with defatted wheat germ (DFWG) at levels of 0–25% was investigated for its effect on functional and nutritional properties of cookies. The crude protein content of DFWG was as high as 27.8% with a highly valuable amino acid profile, rich in essential amino acids, especially lysine (2.32 g/100 g). The physicochemical and sensory evaluation of cookies, revealed that up to 15% substitution of wheat flour with DFWG produced acceptable cookies similar to the control (100% wheat flour) cookies. The protein quality of the cookies was assessed through weanling albino rats by feeding a diet of cookies for 10 days, which was formulated to supply 10% protein, with a casein diet as a control. The cookies containing 15% DFWG, were best regarding protein bioavailability in rats. The protein efficiency ratio (PER), net protein utilization (NPU), biological value (BV) and true digestibility (TD) differed significantly among diets containing cookies with 0–10% DFWG, and casein diet when fed to rats. Diets containing 15% DFWG have values, of these parameters, similar to the casein diet.

Keywords: Defatted wheat germ; Cookies; Physicochemical composition; Protein quality

1. Introduction

The protein foods available commercially are obtained from a range of animal and plant sources and are used as functional ingredients (Periago & Vidal, 1998). The increased costs and limited supplies of animal proteins, have necessitated contemporary research efforts geared towards the study of food properties and potential utilization of protein from locally available food crops, especially from under-utilized or relatively neglected high protein oilseeds and legumes (Enujiugha & Ayodele-Oni, 2003). Wheat germ protein is reported to have a high nutritive value, comparable to that of animal proteins. In the wheat grain, most nutrients, with the exception of starch, are concentrated in germ but most of this is generally used in animal feed formulations, due to which the precious wheat germ source has not been amply, rationally, and efficiently utilized (Shurpalekar & Rao, 1977). The germ provides three times as much protein, seven times as much fat, fifteen times as much sugars and six times as much mineral content than does wheat flour (Rao, Kumar, Rao, & Shurpaleker, 1980).

Defatted wheat germ, after extraction of valuable wheat germ oil, is a high nutritive value protein material, which contains about 30% protein (Ge, Sun, Ni, & Cai, 2000). Wheat germ protein has been classed with effectively superior animal proteins and is rich in amino acids, especially the essential amino acids, lysine, methionine, and threonine, in which many cereals are deficient (Yiqiang, Aidong, & Tongyi, 1999). Therefore, wheat germ is a potential nutritious food supplement; in particular, defatted wheat germ is a source of natural high grade protein, which makes it a good enrichment component for many foods (Moss, Murray, & Stenvert, 1984).

The enrichment of cereal-based foods with oilseed and legume protein has received considerable attention. Wheat bread and cookies are widely accepted and consumed in

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many developing countries and therefore offer a valuable supplementation vehicle for nutritional improvement; however, cookies have been suggested as a better use of composite flour than bread because of their ready-to-eat form, wide consumption and relatively long shelf-life (Lorens, Dilsaver, & Wolt, 1979). Protein enriched cookies are attractive for target areas, such as child-feeding programmes, low-income groups and disaster relief operations (Claughton & Pearce, 1989). Cookies with these characteristics have been produced from blends of wheat and cowpea (McWatters, Ouedraogo, Resurrection, Hung, & Philips, 2003) or soybean and wheat (Shrestha & Noomhorm, 2002). However, there is no information on the use of DFWG in cookie-making. In this study, we attempted to assess the suitability of DFWG utilization for improvement in quality and nutritive value of cookies, and to strengthen the utilization of wheat germ.

2. Materials and methods

2.1. Raw materials and treatment

Wheat was purchased from the Ayub Agricultural Research Institute (AARI), Faisalabad. Straight grade flour was prepared by a UDY cyclone mill in the Institute of Food Science and Technology, University of Agriculture, Faisalabad. After milling of wheat, flour samples were packed in polypropylene bags and stored at room temperature for further study. Raw wheat germ was procured from Sunny Flour Mills, Lahore, Pakistan. Wheat germ contains several enzymes, such as dipeptidase, proteinase, lipase, lipoxidase and phytase. In order to stabilize it, wheat germ was treated by 'Characteristic Far Red' ray technology to kill its enzymes, during which the temperature was 130–160 °C for 20–25 min. Treatment of wheat germ, under these conditions, is reported to be sufficient enough to deactivate enzyme activity (Zwingelberg & Fretzdorff, 1996).

2.2. Preparation of DFWG flour

Wheat germ oil was extracted by a solvent extraction technique, using *n*-hexane (BP. 68 °C). DFWG remaining after oil extraction was crushed and passed through a 200-mesh sieve to obtain DFWG flour, which was used as our experimental material.

2.3. Blends formulation and preparation of cookies

Blends of wheat flour and DFWG flours containing 0%, 5%, 10%, 15%, 20% and 25% DFWG flour, on a replacement basis, were prepared. The choice of these levels was based on the report of Dreuiter (1978) that the maximum level of wheat flour substitution that would produce an acceptable baked product was 25%. They were then packed in polyethylene bags, sealed and stored in a freezer (0–5 °C) until required.

Cookies were prepared according to the procedure described by McWatters et al. (2003) with slight modifications. The basic ingredients used were 380 g of flour blend, 100 g vegetable shortening, 225 g of granulated cane sugar, 21 g of beaten whole egg, 3.75 g of salt, and 1.8 g of baking powder. The dry ingredients were weighed and mixed thoroughly in a bowl by hand for 3–5 min. Shortening was added and rubbed in until uniform. The egg was added and dough was thoroughly kneaded in a mixer for 5 min. The dough was rolled thinly on a sheeting board to a uniform thickness (8.0 mm) and cut out using a round scorn cutter to a diameter of 35.0 mm. The cut out dough pieces were baked on greased pans at 160 °C for 15 min in a baking oven. The prepared cookies were cooled to room temperature (30 ± 2 °C) and packed in high density polyethylene bags.

2.4. Chemical composition of flours and cookies

Amino acid content of DFWG was determined by using an autoanalytic apparatus according to the method of Yu (1994). All reagents used were of analytical grade (BDH Chemicals, Poole, UK).

The moisture, crude protein, crude fat, total ash and crude fibre contents of flours and cookies were determined by AACC (2000). Nitrogen-free extract (NFE) was calculated by difference. The factors, $n = 5.70$ (for wheat flour), and $n = 6.25$ (for cookies) were used for conversion of nitrogen to crude protein. Minerals, including, calcium, iron and potassium, were determined using an atomic absorption spectrophotometer, AAS (Model 372, Perkin–Elmer Ltd., Beaconsfield, UK) by dry-ashing, according to the procedure of the AACC (2000). All reagents used were of analytical grade (BDH Chemicals, Poole, UK).

2.5. Physical and organoleptic evaluation of cookies

Physical parameters, including, diameter, height, weight and hardness, of cookies were measured on three replicates and mean values recorded. Cookie diameters and heights were measured with a vernier caliper. Weights were determined using a Mettler digital top loading balance (PC 400; Mettler, Buchi Switzerland).

Cookies were evaluated for colour, flavour, texture and overall acceptability, according to the preference method of Ihekoronye and Ngoddy (1985). Ten (trained) judges participated in the sensory evaluation of the cookies on a 5-point hedonic scale. The coded cookie samples were randomized and presented to the judges in the midmorning on white plates in the sensory evaluation laboratory, Institute of Food Science and Technology, University of Agriculture, Faisalabad.

2.6. Biological evaluation of protein quality

Based on the results of physicochemical and sensory evaluation of cookies, four best treatments, including con-