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Studies on multigrain milling and its effects on physical, chemical and rheology characteristics of milled streams

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ABSTRACT

The multigrain blends of wheat-green gram-barley in the ratio of C (100:0:0); B1 (90:5:5); B2 (80:10:10); B3 (70:15:15) were co milled using a Buhler roller mill to produce nutritious flour. The studies showed that the yield of straight run flour (SRF) increased gradually with an increase in blending of green gram and barley with wheat. The highest SRF of 79.71% was obtained from the B3 blend. The coarse bran decreased from 15.95% for the control sample to 9.52% for B3 blending. The milling yield of pollard and fine bran showed a decreasing trend from control to B3 blending. In general, flour yield decreased for reduction passages from C1 to C3 and reduction passages produced higher flour compared to break rolls for all blends. The multigrain milling resulted in an increase in protein(113.1–13.35%) and dietary fiber (2.91–4.65%) content of flour, but sedimentation values (52–38 ml), which is the index of flour strength, decreased significantly. The distributions of mineral matters and fat show wide variation among the mill streams and concentrated in coarse and fine brans. The rheological properties of flour obtained showed increased water absorption (55.8–57.5%) and decreased dough stability(5.5–2.8 min), amylograph peak viscosity (388-335BU) and setback (265-224BU) with an increase of multigrain in blends.

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1. Introduction

Wheat is cereal crop and one of the most important staple food grains of the human race. The major proportion of wheat produced in the world is processed into refined wheat flour by roller milling. The main botanical constituents of the wheat are bran, endosperm and germ. The endosperm constitutes over 80% of the wheat kernel. The endosperm contains mainly starch granules embedded in the protein matrix made up of primarily gluten forming proteins. Wheat is milled into the different finished products by the roller milling method. The roller milling process involves cleaning and conditioning of wheat to prepare it for milling. The roller milling process involves breaking open the grain, gradual scraping of the endosperm from bran by break rolls and then gradually reducing the chunks of the endosperm into flour by a series of grindings by reduction rolls, with intermediate separation of products by sifters & purifiers (Bass, 1988). Resulting flour obtained in each grinding roll is combined to obtain the straight run flour. The nutritional constituents are non uniformly distributed within the wheat kernel, which gives different composition and functional properties of different streams (Dewettinck et al., 2008). The flour granularity, protein content, ash content, fat content, damaged starch, as well as intensity of enzyme activity, and fiber content vary with the type of mill stream (Prabhasankar et al., 2000; Banu et al., 2010). The protein and ash content of mill streams increases with an increase in break and reduction passages (Sakhare and Inamdar, 2011).

Legumes have an important place in human nutrition, particularly in India. Legume seeds are rich in proteins and complex carbohydrates (dietary fibers) and are an important source of minerals and vitamins. Consumption of legumes has many beneficial effects in controlling and preventing metabolic diseases like diabetes mellitus, lowering cholesterol, coronary heart disease and colon cancer (Shehata et al., 1988). Legumes are higher in proteins than cereal grains and can be used to improve the amino acid balance (Rababah et al., 2006). Green gram is a protein rich staple food. Whole Green gram is widely used in India and is consumed in the form of cooked curry and the split green gram and deep fat fried snack item. Among the legumes, green gram has relatively low amounts of protease inhibitors, polyphenols and amylase inhibitor activities (Adsule et al., 1986). It contains about 25 percent protein, which is almost three times that of cereals. Generally green gram is milled to convert dal by removing outer husk and splitting the grain into two equal halves. Recently, Sakhare et al. (2013a) fractionated green gram by roller milling to evaluate its roller milling potential

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List of abbreviations

AACC	American Association of Cereal Chemist
a	Redness
AOAC	Association of Official Analytical Chemists
b	Yellowness
B1	Blend One
B2	Blend Two
B3	Blend Three
BF	Break Flour
BK1	Break One Passage
BK2	Break Two Passage
BK3	Break Three Passage
BU	Brabender Units
C	Control Sample
C1	Reduction One Passage
C1F	First Reduction Flour
C2	Reduction Two Passage
C2F	Second Reduction Flour
C3	Reduction Three Passage
C3F	Third Reduction Flour
CB	Coarse Bran
FB	Fine Bran
IDF	Insoluble Dietary Fiber
L	Lightness
PL	Pollard
SDF	Soluble Dietary Fiber
SRF	Straight Run Flour
TKW	Thousand Kernel weight

and to study the effect of conditioning moisture on milling yield. The roller milled fractions of green gram were evaluated for the different chemical characteristics. The results showed that roller milling of the green gram generated different fractions with high variation in composition.

Barley accounts for 12% of the world's total cereal production and occupies fourth position with respect to grain production after wheat, rice and corn (Jadhav et al., 1998). Barley grains are an excellent source of many nutrients such as soluble and insoluble dietary fibers, vitamin B complex, minerals and phenolic compounds. Barley is getting renewed interest as an ingredient in the production of functional foods due to its higher content of bioactive compounds. De-hulled barley grain contains 11–20% total dietary fiber, 11–14% insoluble dietary fiber and 3–10% soluble dietary fiber (Virkki et al., 2004). Studies have been conducted in which hull-less barley has been experimentally milled to obtain flour and bran (Klamczynski and Czuchajowska, 1999; Kiryluk et al., 2000). New and nutritionally valuable barley products may be obtained by using a wheat roller mill with certain adjustments (Kiryluk et al., 2000). Hence, the present study aims at multigrain milling of wheat-barley-green gram blends and its effect on the quality of the flours. The roller milled streams and products were evaluated for the different nutrition, rheology characteristics. Multigrain milled flours were evaluated by the bread baking test.

2. Materials and methods

2.1. Materials

Commercially available wheat, green gram and pearled barley were procured from the local market and used for the studies. The pearled barley is used as barley throughout the manuscript. All the reagents and chemicals used are of analytical grade (AR) unless otherwise specified.

2.2. Preparation of grains for milling

Green gram sample was cleaned and conditioned to raise the moisture content to 16–18% followed by drying in the oven for the desired moisture content. The sample of cleaned green gram was weighed and poured into the batch rotary drum mixer. Total quantity of water for the batch was divided into 2–4 fractions and sprinkled on the grains. After each sprinkling, the mixture was rotated for about 5 min and about 1 h at the end. The conditioned grain were removed from the closed drum after 12 h and placed in a rectangular wire mesh for drying in a drier at 65 °C to get desired moisture content of 10% required for the roller milling of green gram (Sakhare et al., 2013a). The blends of cleaned wheat and barley were conditioned to 15.5% moisture into the batch rotary drum. Total quantity of water for the batch was divided into 2–4 fractions and sprinkled on the grains. After each sprinkling, the mixture was rotated for about 5 min and about 1 h at the end. The lid of the mixture was tightly closed and kept for 24 h before milling.

2.3. Physicochemical characteristics of grains

The grains were analyzed for moisture (method 44-15), ash (method 08-01), protein (method 46-10), fat (method 30-10) according to the standard methods (AACC, 2000) and dietary fiber (method 991.43- according to AOAC method, 1999).

Hectoliter weight and the thousand-kernel weight (TKW) were determined by standard procedures (Pomeranz, 1988). The grains seed dimensions such as length, width and thickness were measured by a digital vernier caliper in randomly selected 100 seeds.

The individual grains were compressed with 50 kg load cell at a test speed of 1 mm/s using a food texture analyzer (Stable Microsystem, Model TA-HDi, Surrey, UK). The maximum force required to compress the grains to 80% of their original size was recorded. The average peak force (N) value from 10 individual kernels was taken as a measure of hardness. All results were expressed on dry weight basis.

2.4. Preparation of multigrain blends for milling

The prepared wheat, barley and green gram were combined for multigrain milling. The blends were prepared using the mixture of wheat, barley and green gram in the ratio of C (100:0:0); B1 (90:5:5); B2 (80:10:10); B3 (70:15:15). The wheat and barley was blended before the conditioning treatment. The pre-treated green gram by conditioning and drying were mixed with conditioned blends of wheat and barley before the roller milling.

2.5. Multigrain milling

The prepared blends and control samples were milled using a Buhler laboratory mill type MLU-202(Buhler Inc., Uzwil, Switzerland). The Buhler laboratory-scale mill, which is a six passages roller mill, consists of three breaks (BK1–BK3) and three reduction rolls (C1–C3). Each of the passages was followed by the sifter with two size separation. The break rolls (BK1–BK3) were

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