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Chemical and scanning electron microscopic studies of wheat whole-meal and its streams from roller flour mill

G.H. Gangadharappa, R. Ramakrishna, P. Prabhasankar *

Flour Milling, Baking and Confectionery Technology Department, Central Food Technological Research Institute, Mysore 570 020, Karnataka, India

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Abstract

Wheat whole-meal (WWM) flour is commonly used in Asian breads such as *roti* and *chapati*. WWM has higher damaged starch and ash content. Unlike wheat flour, WWM contains the some amount of bran. This is due to during the milling process of WWM; larger bran particles are preferably sifted out, leaving smaller bran particles. Chemical and microstructure changes occurring during processing of wheat into WWM were evaluated by analyzing mill stream (C4, C5 and WWM) samples from a pilot mill. The ash content was 0.43%, 0.90% and 0.75%; while damaged starch content was 8.30%, 10.70% and 10.31% in C4, C5 and WWM streams, respectively. Ash and damaged starch contents were higher in C5 stream as compared to the C4 stream. However, both these parameters were lower in the case of WWM stream, which was a homogenized mixture of C4, and C5 streams. A similar trend was observed for the protein contents of C4, C5 and WWM streams. Scanning electron microscopy (SEM) studies showed A type (lenticular shaped) starch granules without much structural deformation in the C4 stream. On the other hand, deformed A-type and intact B-type (spherical shaped) starch granules were seen in the C5 stream. A WWM stream micrograph revealed a combination of deformed and intact starch granules embedded in the protein matrix. Hence, the present study indicated that there is a relationship between chemical characteristics and microstructure of WWM.

Keywords: Wheat whole meal; SEM; Millstream; Wheat; Damaged starch; Micrograph

1. Introduction

Asian breads such as *chapati* and *roti* are produced using wheat whole-meal (WWW) as the basic ingredient. Grinding the wheat in a stone mill produces WWM and it invariably has specific characteristics such as high levels of damaged starch and ash with desirable colour and granulation. Mechanical stone mills have a small capacity and do not fulfill the market requirements (Prabhasankar & Haridas Rao, 2001).

In a roller flour mill, mixed granular stocks of semolina and bran released from break passages are processed in a purifier to separate clean semolina and composite stock. Clean semolina from the purifier is then reduced to a fine flour by a reduction system. Flour is then sieved or graded by sifting the ground stock over coarse and fine sieves. Coarse sieves separate finer bran flakes. Repeated grinding and sifting arrangements gradually reduce the size of the intermediate milled products. A stock that overtails the fine sieve, at the end of the reduction system, is termed pollard. WWM is distinct from refined wheat flour in bran content (IS, 1968).

Wheat endosperm mainly contains starch granules embedded in gluten forming a protein matrix (Pyler, 1988). Cryo-SEM micrographs of wheat endosperm have revealed densely packed cells with intact, large, (A-type) and small (B-type) starch granules without any deformation in their structures (Angold, 1975). Wheat flour preserves some characteristics of the intact endosperm tissue but the original, compactly packed structure of the kernel breaks up into aggregates of protein matrix that is embedded in groups of cellular components, mainly starch

* Corresponding author. Tel.: +91 821 2517730; fax: +91 821 2517233.
E-mail address: prabhasankar@lycos.com (P. Prabhasankar).

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granules. Starch granules are deformed as a consequence of milling (Rojas, Rosell, Benedito de Barber, Perez-Munuera, & Lluch, 2000).

Although the primary damage is observed in the A-type starch granules as compared to intact B-type starch granules, the proportion and percentage of damaged starch depends on grinding and increases with the severity of grinding (Baltensperger Werner et al., 1996; Prabhasankar & Haridas Rao, 2001; Wilson, Bechtel, Todd, & Sieb, 2006).

A number of reports on the effect of milling process on chemical characteristics of milled products and millstreams pertaining to production of refined wheat flours are available (Haddad, Mabille, Marmet, Abecassis, & Benet, 1999; Prabhasankar & Haridas Rao, 1999; Prabhasankar, Sudha, & Haridas Rao, 2000; Prabhasankar, Vijaya Kumar, Lokesh, & Haridas Rao, 2001). However, reports on the microstructure of WWM and its respective streams are scarce. Hence, the present study to evaluate the physical and microstructural changes that occur during processing of wheat to WWM will help to understand and optimize the milling process.

2. Materials and methods

2.1. Raw material

Commercially available wheat grain (Indian variety PBW 343) was used for the present study. Physico-chemical characteristics such as moisture, ash, sodium dodecyl

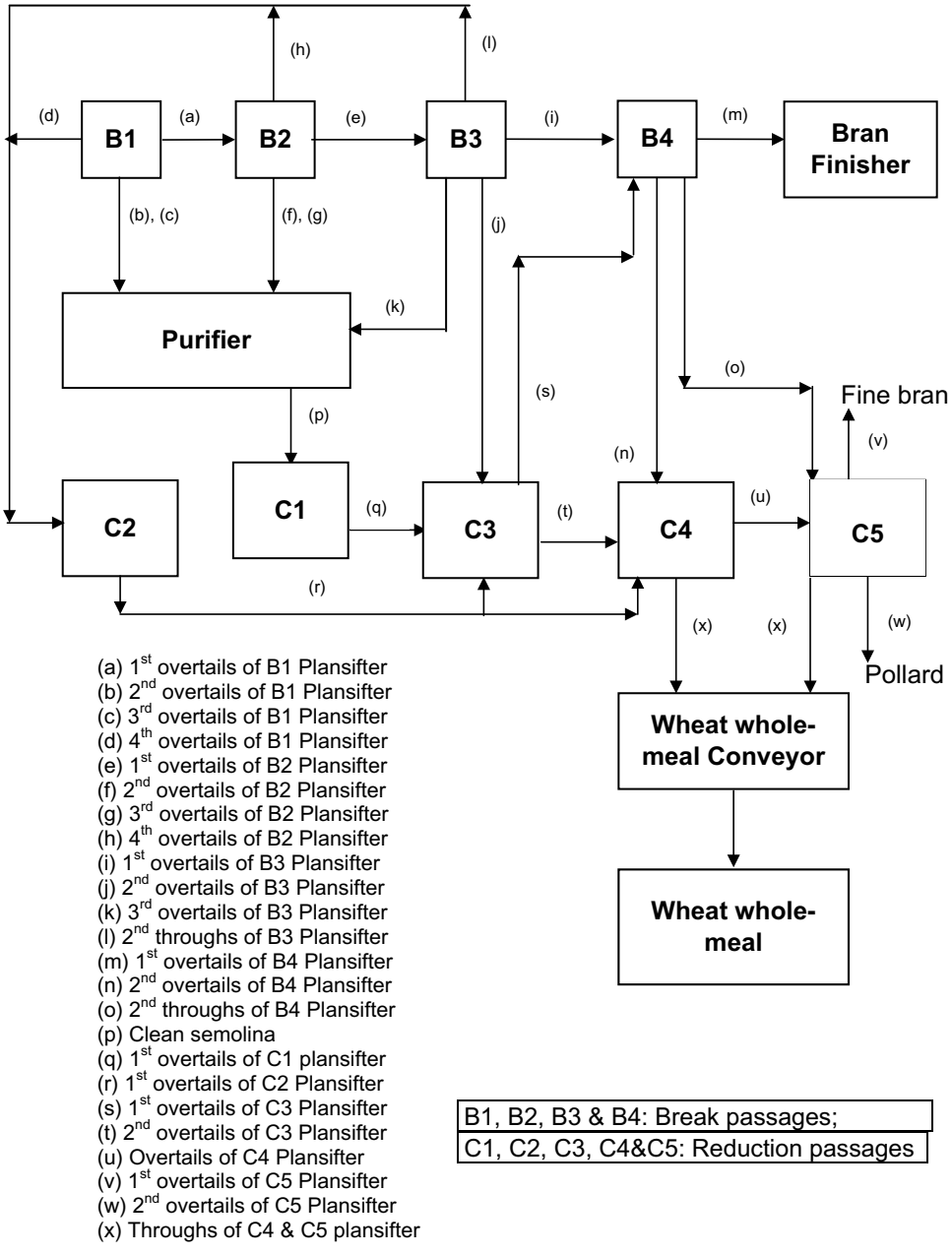

Fig. 1. Wheat whole-meal milling flow diagram.