P. mollissimum differ little from that of cultivated *P. glaucum*. The only major difference observed is a 40 cM internal inversion on LG1 in *P. mollissimum* relative to *P. glaucum*. Thus the transfer of useful genes from these subspecies can, in the main, be accomplished without the production of unbalanced genomes.

Work is underway to make the maps more complete (filling gaps, adding telomeres, etc.), provide more informative PCR markers, tag a number of key agronomic genes and relate the pearl millet genome to those of other grasses, including wheat, maize and rice, to provide an improved across-crop comparative capability for pearl millet breeders and geneticists.

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Downy Mildew Resistance QTLs from a Seedling Heat Tolerance Mapping Population

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Scientists at ICRISAT Asia Center (IAC), Patancheru, India, and the Institute of Grassland and Environmental Research (IGER), UK, have jointly produced two pearl millet mapping populations to tag genes that control seedling heat tolerance of elite inbred pollinator H 77/833-2 (Howarth et al. 1994). The restriction fragment length polymorphism (RFLP)-based skeleton map for a population derived from a cross between H 77/833-2 and ICMP 451 was completed in 1994 at IGER. Field data on downy mildew (DM) incidence (Patancheru field population of *Sclerospora graminicola*), flowering time, and 1000-grain mass were collected from a trial with three replications conducted in the 1994 dry season DM nursery at IAC using F_4 self bulks derived from 94 of the 154 mapped F_2 plants. Combining these two data sets using interval mapping procedures with MapMaker/QTL 1.1 (Lincoln et al. 1992) permitted evaluation of the ability of the map to detect quantitative trait loci (QTLs). Of the two QTLs for DM resistance detected from ICMP 451, one was in linkage group 1 (LG1) at a position similar to DM resistance QTLs previously detected from P 7-3 and ICMP 85410 (Jones 1994, Jones et al. 1994, Jones et al. 1995). Together, these two QTLs accounted for nearly 90% of the variation for DM incidence in the mapping population in this trial. Three QTLs of large effect were detected for 1000-grain mass—one in LG2 and two in LG4. For flowering time, one QTL of large effect (accounting for 35% of variation) was identified in LG6, along with another of smaller effect in LG1. Late flowering of ICMP 451 was tightly linked to its DM resistance QTL in LG1. This evidence of linkage between QTLs controlling flowering and DM reaction may explain some of the difficulties experienced by breeders seeking early-flowering, DM-resistant recombinants.

These results indicate that the skeleton map for the mapping population derived from ICMP 451 × H 77/833-2 is suitable for identifying QTLs for traits having high heritabilities. Success in mapping QTLs for seedling heat tolerance—the primary target trait for this population—will be possible if heat tolerance screening heritabilities are improved.

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Food and Feed Quality

Effect of Various Processing Treatments on Phytic Acid, Polyphenols, and Amylase Inhibitors of Pearl Millet

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Introduction

In regions characterized by low and erratic rainfall, high temperature, low soil fertility, and numerous biotic stresses, pearl millet gives higher and more stable grain yields than any other cereal grown there. In Haryana, the crop covered an area of 0.67 million ha with a production of 0.76 million t in 1992/93 (Anonymous 1994). Although the nutritive value of pearl millet is comparable to other cereals (Gopalan et al. 1989), due to the presence of such antinutrients as phytic acid, polyphenols (Aggarwal 1992), and amylase inhibitors (Udupa et al. 1989), it has problems regarding its nutrient bioavailability. Phytate and polyphenols cause mineral deficiencies and inhibit proteolytic and amylolytic enzymes (Sutardi and Buckle 1985, Thompson and Yoon 1984), whereas amylase inhibitors are proteinaceous inhibitors of alpha amylases.

Various processing treatments help in reducing antinutrients. Antinutrients are leached out during soaking and are removed after autoclaving. During germination, such enzymes as phytase and polyphenol oxidase are activated.

Materials and Methods

Grains of the pearl millet variety HC 4, produced at the Research station of CCS Haryana Agricultural University, Hisar, were processed using various treatments. The treatments included coarse grinding (to pass through a 1.5-mm sieve size), soaking in water for 12 h, debranning by hand-pounding after tempering with water to obtain 16% moisture, heating at 1.05 kg cm^{-2} pressure for 10 min, and germination for 48 h at 30°C. All the treated samples were autoclaved after adding appropriate amounts of water at 1.05 kg cm^{-2} pressure for 10 min. The samples were then dried at 60°C in a hot-air oven to constant weight, powdered, and stored in air-tight containers. Phytic acid was analyzed by the method of Haug and Lantzsch (1983). Polyphenols were extracted by the procedure outlined by Singh and Jambunathan (1981) and analyzed according to the method of Swain and Hillis (1959). Amylase inhibitor activity was determined by the modified method of Bernfeld (1955) while one unit of amylase activity was equivalent to the conversion of one mg starch to maltose in 20 min at 37°C at pH 7.6. Data obtained were subjected to analysis of variance according to the method of Snedecor and Cochran (1967).

Results

Phytic acid was reduced significantly after various processing treatments. Germination caused a reduction from 808.2 mg 100 g^{-1} (control) to 451.2 mg 100 g^{-1} phytic acid, which further declined to 258.7 mg 100 g^{-1} after autoclaving (Table 1). The level of polyphenols could be reduced effectively by all the treatments except coarse