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Comparison of tungsten carbide and stainless steel ball bearings for grinding single maize kernels in a reciprocating grinder

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When grinding many corn kernels at once, there are several different options to choose from, but single kernel grinding is limited to few options with relatively low throughput. An attractive alternative is a reciprocating grinder with 3/8" grinding balls and a 4ml polycarbonate vial set. This format allows grinding of 24 samples simultaneously, which is a significant improvement to grinding throughput. A reciprocating grinder like the Talboys HT Homogenizer (Troemner, Thorofare, NJ), operates by violently shaking the 4ml polycarbonate vials containing a bearing and a single kernel. In our experience, stainless steel ball bearings do not lead to a satisfactory grind in this system. We reasoned that higher-density bearings should perform better. Tungsten carbide ball bearings are twice as dense as stainless steel and are available in the correct size. The objective of this experiment was to compare the grinding quality between steel and tungsten carbide bearings.

Four corn genotypes with a wide range of hardness were selected. The genotypes chosen were, in order starting with the softest, *floury2*, a mutant with exceptionally floury kernels; B73, a typical corn- belt dent variety; commercial popcorn; and Uruguay 16A, a flinty variety. Kernels of each corn genotype were randomly selected from a single ear packet as follows: two kernels were blindly selected from each packet followed by a random coin flip to choose which kernel would be used between the two. For each corn genotype, this randomizing process was carried out six times resulting in selection of six kernels of each genotype. Every kernel from each genotype was weighed prior to the experiment so percent recovery could be calculated.

Each kernel was then placed into an individual 4ml polycarbonate grinding vial, with either one 3/8" tungsten carbide bearing (Dennis Kirk, Rush City, Mn, Manufacturer Number: SSCBB) or one 3/8" stainless steel bearing (Troemner, Thorofare, NJ, serial number 930156) placed on top of the kernel before twisting the lid shut. Next, the twenty-four samples were placed into the HT Homogenizer with a random vial arrangement. The samples were then ground in the Talboys HT Homogenizer (Troemner, Thorofare, NJ) for two minutes on maximum speed then the vials were inverted and ground for an additional two minutes(dial setting 10). Following grinding, particle size distributions were determined using a Sonic Sifter Separator by Advantech MFG**,** which had four different sieve sizes, ranging from 150 micron to 1000 micron as well as a collecting container at the bottom of the sieve screens for <150 micron particles. The sieve screens were weighed in advance; therefore, the weight of the each corn sample on each sieve screen could be determined after sonication by weighing the screen and its contents after separation. The contents of each 4ml vial were separately placed into the Sonic Sifter Separator for a one minute and thirty second cycle on amplitude eight with sift-pulse.

Recoveries were high with both types of bearings (Table 1), with only one treatment falling below 90%. Tungsten carbide bearings gave more uniform recoveries, varying between 92.2 and 90.6%, while recoveries from grinds with stainless steel bearings ranged from 87.3 and 96.7%.

With stainless steel bearings, in three out of four genotypes over half of the recovered material was in the coarsest fraction (Table 2). By contrast, with tungsten carbide bearings the coarsest fraction contained less than half of the material in all genotypes. In addition, tungsten carbide bearings produced more material in the finest fraction in all genotypes than stainless steel bearings.

The *floury2* genotype was the softest grain in the study and there was very little difference in the distribution of mass between tungsten carbide and stainless steel bearings. This suggests that for very soft kernels, stainless steel bearings may be adequate. For all other genotypes, tungsten carbide bearings gave clearly better results.

Table 1. Average percent recoveries from the three kernels from each genotype ground for each bearing type.

Corn Genotype	Tungsten carbide	Stainless steel
B73	91.1	96.7
Uruguay 16A	91.6	92.8
Popcorn	92.2	87.3
fl2	90.6	93.9

Table 2. Particle size distribution showing percentage of starting mass retained by each screen following grinding and sieving.

	Tungsten carbide				***Stainless steel***			
Sieve size (microns)	*B73*	*Floury2*	Popcorn	*Uruguay 16A*	*B73*	*Floury2*	Popcorn	*Uruguay 16A*
Fine <150	9.804	3.223	23.936	6.935	6.376	1.921	7.0453	5.133
150	16.630	8.269	33.536	21.893	12.518	14.719	3.695	9.346
250	20.953	14.380	21.786	18.966	9.371	16.583	6.931	9.563
500	19.994	24.726	8.193	18.033	10.706	24.200	7.479	7.622
Coarse 1000	23.393	40.090	8.0423	25.770	57.760	36.473	61.889	61.973

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