DEVELOPMENT OF AN EARLY GENERATION TEST FOR PREDICTING COLOR LOSS OF BLACK BEANS

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Retention of color in black seeded bean from the dry condition to the canned or cooked product (thermally processed) is an important consumer and processor expectation. Many black bean cultivars and breeding lines leach during thermal processing giving an end product that is gray to reddish brown. Color loss of processed black bean is unappealing and often results in severe consumer dissatisfaction. Prior study has indicated that color retention after cooking is heritable and may be altered through plant breeding. Typically the selection for cooked bean color- an important canning quality trait- is not made until the F5 or F6 generation when the large quantities of seed needed for the tests are available. The development of tests for predicting color retention of black beans after thermal processing, which are rapid, relatively inexpensive, and amenable to small samples, would allow testing in early generations after hybridization; thus saving time and fiscal resources.

A recombinant inbred population of black bean was used to develop a test predictive of color retention on small samples (less than 25g of beans). The essentials of the test were to determine whether the amounts of water imbibition and color loss due to soaking were related and ascertain the effect of seed coat shininess on color loss.

The test population consisting of 98 lines plus the two parents, 'Shiny Crow' and 'Black Magic', was grown near Christchurch, New Zealand during the winter of 2002-2003. Of the 98 lines, 36 were still segregating for shiny or opaque seed coats and were omitted from the experiment. The remaining 62 (F3:7) lines plus the two parents were used in the water uptake experiments.

Two samples of ten beans from each line were selected, weighed and placed into a 25 ml vial with 10 mls of distilled water that had been adjusted to 100 mg·ml Ca^{+2} with CaCl. The vials were placed into a water bath at 83° C for ten minutes to simulate the high temperature blanch used by many canners in the commercial processing industry. The beakers were then removed from the water bath and placed in the dark for the remainder of the experiment. Twenty minutes following removal from the water bath and at 30 minute intervals thereafter for a total experiment time of 120 minutes, the seed was removed from each beaker, blotted dry and weighed. The amount of water absorbed by the seeds through imbibition was determined and expressed as the increase (% w/w) of the ten seeds.

At the conclusion of the water uptake experiment, the beans were removed from the soak water and the water from each beaker was then transferred into a clean 10 ml vial. The water color was rated on a 5-point scale that was developed using a Munsell Color Chart. Exposure of the vials to light will rapidly change the color of the soak water, thus color scale ratings were done immediately. The 5 point scale was developed to correspond to the color of the water, from essentially colorless (scale = 1) to dark black (scale =5).

To ascertain the linearity of the color scale, the means of the number of RILs that fell into each color category were plotted against percent water uptake. This correlation was r=0.99 (data not shown). The shiny lines fell into categories 1 and 2 while the opaque lines fell mostly into categories 3, 4 and 5. Category 2 of the color scale was the only category where both shiny and

opaque RILs overlapped in score with the opaque RILs accounting for only 1 of the 11 RILs that fell into this category (Figure 1).

There were significant correlations between the color of the soak water and the amount of water imbibed after 120 minute soaking (r=0.96), seed shininess and the color of the soak water (r=0.93) and seed shininess and the amount of water imbibed (r=0.91) (Table 1). Overall, RILs with opaque seed coats imbibed more water over time, 24% to 65%, than the RILs with shiny seed coats, 2% to 30% (Figure 1).

The results of the current experiments indicate that color retention in black bean after thermal processing can be predicted by soaking beans for 120 minutes and comparing the soak water color. This test is rapid, inexpensive, fairly accurate and can be performed on small seed samples- this feature makes it useful to screen bean genotypes as early as the F3 generation. It must be pointed out though that the current results are only valid for this RIL population. Further testing in other populations is necessary before generalizations regarding color loss and water absorption of soaked beans can be extended to all black bean lines. However, experience in this laboratory with soaking and the amount of color loss noted appears to be a general phenomenon in black beans.

Table 1. Pearson Correlation Coefficients Comparing Percent Water Uptake, Shininess, and Color of the Soak Water Following a 120 Minute Soak.

	Percent Water Uptake	Color	Shininess
Percent Water Uptake	1.00	0.96	0.91
Color	0.96	1.00	0.93
Shininess	0.91	0.93	1.00

Figure 1. Mean Percent Water Uptake for 64 Black Bean Lines