

# Color vision system to assess English walnut (*Juglans Regia*) kernel pellicle color

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## Abstract

English walnut (*Juglans regia*) kernel pellicle color is an important component of consumer quality, as a breeding phenotype attribute, and a key factor affecting marketing price. It is part of the United States Department of Agriculture (USDA) grading criteria and it is assessed by trained Dried Fruit and Tree Nuts Association (DFA) of California inspectors, who visually segregate kernels into four DFA color categories: 1 ('Extra light'), 2 ('Light'), 3 ('Light Amber'), and 4 ('Amber'). The establishment of an objective and fast Color Visual System (CVS) will remove human variability and bias, adding consistency and can speed-up the color evaluation process. Therefore, a portable CVS was designed, built and its performance was evaluated using three datasets of kernels, with a diverse range of pellicle colors: 2,000 from a UC Davis seedling population, 1,238 from 'Chandler', and 857 from 'Howard' cultivars. Kernel pellicle color was measured using the DFA (1 to 4) visual scoring system, a colorimeter and the CVS. Relationships between these methods were analyzed using correlation, density plots, and stepwise logistic regression methodology was further applied to create a set of CVS kernel pellicle color prediction models, which can classify kernels into the DFA color categories. The CVS could segregate all 4095 kernel samples into the DFA color categories with an accuracy equal to 68.9 %. The use of independent prediction models per dataset significantly improved prediction: the 'Chandler' model was most accurate (88.8 %), followed by the seedling (80.4 %) and 'Howard' (75.1 %) models. Therefore, it is recommended that a cultivar-specific model be used to improve grading prediction accuracy. Model accuracy performance was further improved when the number of color categories was reduced to two categories by combining 1 ('Extra Light') and 2 ('Light') (Category 1), and 3 ('Light Amber') 4 ('Amber') (Category 2). Overall, the CVS used with a dataset-specific model described overall kernel pellicle color much better than a single colorimeter reading, making CVS a

promising tool to assess kernel pellicle color. The CVS can be used as an objective and consistent method during commercial walnut kernel pellicle color grading and/or high-throughput phenotype breeding evaluation.