# Accelerated Fruit Libraries to Predict Storage Potential of ‘Hayward’ Kiwifruit Grower Lines

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# Abstract

Reducing postharvest losses is a major challenge of the kiwifruit industry. Inherent variability between kiwifruit grower lines makes the prediction of postharvest storage quality a difficult task. This research aims to establish an Accelerated Fruit Library (AFL) rapid test methodology to collect data that would enable *a priori* segregation of 'Hayward' kiwifruit grower lines for storage potential. In the AFL, fruit losses were accelerated by storing at 20 °C and measured regularly at 3 day (d) intervals. The resulting pattern of losses in the AFL was assumed to reflect the losses in optimal storage (0 °C). Results from a preliminary study found that late harvested lines in the AFL displayed a more rapid decline in firmness than those harvested earlier, corresponding with the highest recorded ethylene contamination in the room. Therefore, later AFL attempts were refined by storing each grower line in a flow through system to maintain ethylene independence. The refined AFL methodology ensured expression of inherent loss patterns of each grower line. From the AFL data, parameters describing the distribution, variability and defect count were extracted. Number of fruit < 0.6 $kg_f$, 1st quartile, 3rd quartile firmness, mean and median firmness, SSC:firmness ratio and number of rots during AFL monitoring were slightly correlated ($r \geq |0.5|$) with fruit firmness at 126 d of optimal storage. None of the AFL parameters had consistent correlation ($r \geq |0.5|$ continuously at more than two measurement occasions) with storage firmness. Later, AFL softening curves were described with the Complementary Gompertz equation using the non-linear mixed effects procedure for fitting. Grower lines with higher fitted rate of firmness change parameter ($\kappa$) during AFL monitoring had a tendency to have low firmness at 100 and 126 d of optimal storage ($r$ = -0.53 and -0.45 respectively). Using the fitted $\kappa$ as a segregation guide, 60% of grower lines were successfully categorised into 1 of 3 storage potential categories (i.e. low, medium and high). Notably, $\kappa$ successfully identified 90% of the low storage grower lines. Removing grower lines identified as low storing (65% of whole population) changed the proportion of observed low storing lines in the remaining population from 35% to 10%. However, in the next season where validation of the AFL methodology was conducted, using the fitted $\kappa$ as a segregation tool resulted in only 53% of grower lines being correctly categorised. Meanwhile, 78% of grower lines with low storage potential were accurately predicted. However, removal of lines categorised as low storing (64.7%

of whole population) changed the proportion of observed low storing lines in the remaining population from 53% to 33.3%. Overall, the AFL methodology could have potential to segregate grower lines with different storage potentials but unfortunately higher proportion of low storing lines in the remaining population categorised as medium and high storage restrict its industrial application. Further development of the AFL methodology to predict storability of kiwifruit grower lines may be achieved with incorporation of pre-harvest information (change in fruit quality e.g. SSC and firmness on vine), compositional attributes (amount of minerals e.g. calcium), physiological indicators (e.g. respiration rate and ethylene production) and processes (e.g. cell wall changes and enzymatic activity) of fruit ripening during storage.

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| | |
|---|---|
| AFL | accelerated fruit library (s) |
| $A_o$ | lower asymptote of softening curve |
| $B$ | upper asymptote of softening curve |
| β | horizontal shift factor of softening curve |
| CG | complementary Gompertz |
| °C | degree Celsius |
| cm | centimetre (s) |
| CMM | complementary Michaelis–Menton |
| $CO_2$ | carbon dioxide |
| d | day (s) |
| DM | dry matter (%) |
| EXP | exponential |
| FF | flesh firmness |
| g | gram (s) |
| GL | grower line (s) |
| h | hour (s) |
| IEP | inverse exponential polynomial |
| ISO | international organisation for standardisation |
| JMM | jointed Michaelis - Menten |
| $\kappa$ | rate of softening |
| $\kappa_\alpha$ | threshold limit for higher $\kappa$ value (s) |
| $\kappa_\beta$ | threshold limit for lower $\kappa$ value (s) |
| kg | kilogram (s) |
| $kg_f$ | kilogram force |
| L | litre (s) |
| MAE | mean absolute error |
| MB | modular bulk (s) |
| Mg | magnesium |
| min | minute (s) |
| mm | millimetre (s) |
| µL | microlitre (s) |

| | |
|---|---|
| mL | millilitre (s) |
| n | number |
| N | newton |
| NZ | New Zealand |
| nL | nanolitre (s) |
| nlme | non-linear mixed effects |
| $O$ | observed |
| $P$ | predicted |
| ppb | part per billion (s) |
| ppm | part per million (s) |
| pptv | part per trillion volume (s) |
| % | percent |
| $r$ | correlation coefficient |
| RH | relative humidity (%) |
| s | second (s) |
| SF | soft fractile |
| SSC | soluble solids content |
| t | time |
| $\tau$ | time shift |