$$\left(P+\sum_i k_i\frac{y_i}{y}\right)^2 y-\sum_\ell \left(P+k_\ell+\cdot\cdot+k_m\right)^2\left(y_\ell-y_{\ell-1}\right)=\sum_{i<j}k_i\cdot k_j\left(y_j-y_i\right)\left(1-\frac{y_j-y_i}{y}\right)$$

$$\text{LHS} \;=\; P^2 y+\sum_i k_i^2\frac{y_i^2}{y}+2\sum_i P\cdot k_i\,y_i+2\sum_{i<j}k_i\cdot k_j\frac{y_iy_j}{y}$$

$$-P^2\sum_\ell\left(y_\ell-y_{\ell-1}\right)-\sum_i k_i^2\sum_{\ell\leqslant i}\left(y_\ell-y_{\ell-1}\right)-2\sum_i P\cdot k_i\sum_{\ell\leqslant i}\left(y_\ell-y_{\ell-1}\right)-2\sum_{i<j}k_i\cdot k_j\sum_{\ell\leqslant i}\left(y_\ell-y_{\ell-1}\right)$$

$$=\sum_i k_i^2\left(\frac{y_i^2}{y}-y_i\right)+2\sum_{i<j}k_i\cdot k_j\left(\frac{y_iy_j}{y}-y_i\right)=-\sum_{i<j}k_i\cdot k_j\left(\frac{y_i^2}{y}-y_i+\frac{y_j^2}{y}-y_j\right)$$

$$+2\sum_{i<j}k_i\cdot k_j\left(\frac{y_iy_j}{y}-y_i\right)=\sum_{i<j}k_i\cdot k_j\left(2\frac{y_iy_j}{y}-2y_i-\frac{y_i^2}{y}+y_i-\frac{y_j^2}{y}+y_j\right)\;=\;\text{RHS}$$

$$y\left(P+\sum_i k_i\frac{x_1+\cdot\cdot+x_i}{y}\right)^2-\sum_\ell\left(P-k_1+\cdot\cdot+k_{\ell-1}\right)^2x_\ell$$

$$=y\left(P+\sum_i k_i\frac{x_1+\cdot\cdot+x_i}{y}\right)^2-\sum_\ell\left(P+k_\ell+\cdot\cdot+k_m\right)^2x_\ell$$

$$=\sum_{i<j}k_i\cdot k_j\left(x_{i+1}+\cdot\cdot+x_j\right)\left(1-\frac{x_{i+1}+\cdot\cdot+x_j}{y}\right)$$

$$\int_{dP}^{1:d^{\mathbb{R}}}\prod_i\sqrt{x_i}^{\left(P-k_1-\cdot\cdot-k_{i-1}\right)^2}=\prod_{i<j}\left(\overbrace{x_{i+1}\cdot\cdot x_j}^{-1/2}\exp\left(\frac{\log^2 x_{i+1}\cdot\cdot x_j}{2y}\right)\right)^{k_i\cdot k_j}$$