Electronic Supplementary Information

Optimization identification of cheese products based on Raman spectroscopy and extreme learning machine

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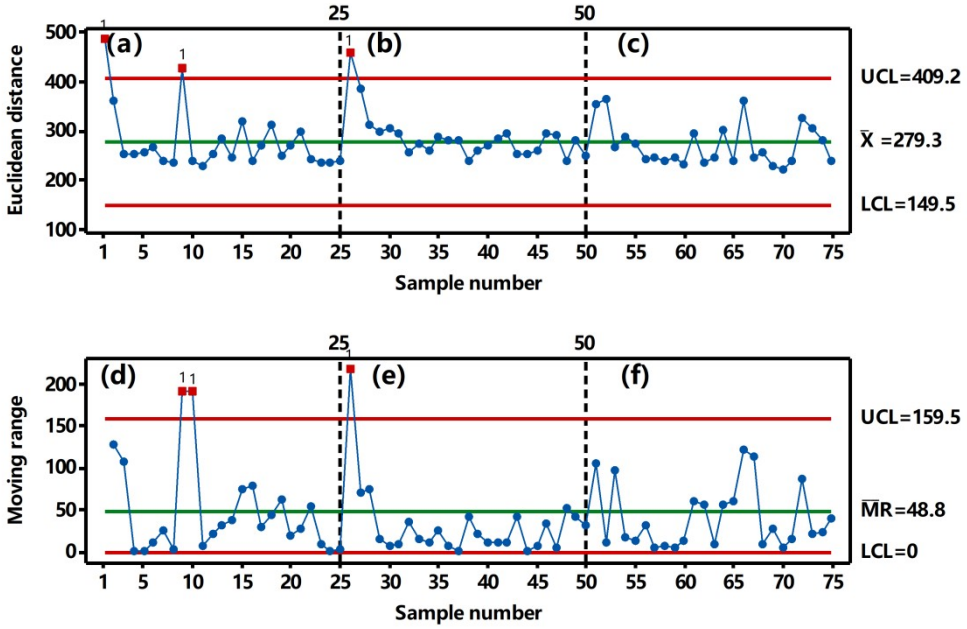

Figure S1 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 10 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\overline{x}$ =the average value of individual control chart.

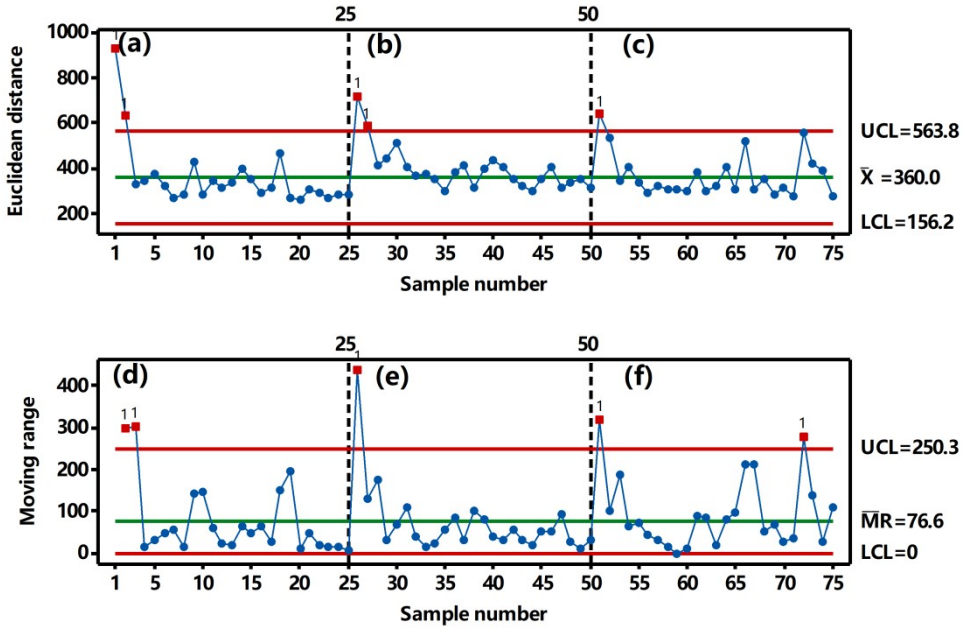

Figure S2 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 20 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\overline{x}$ =the average value of individual control chart.

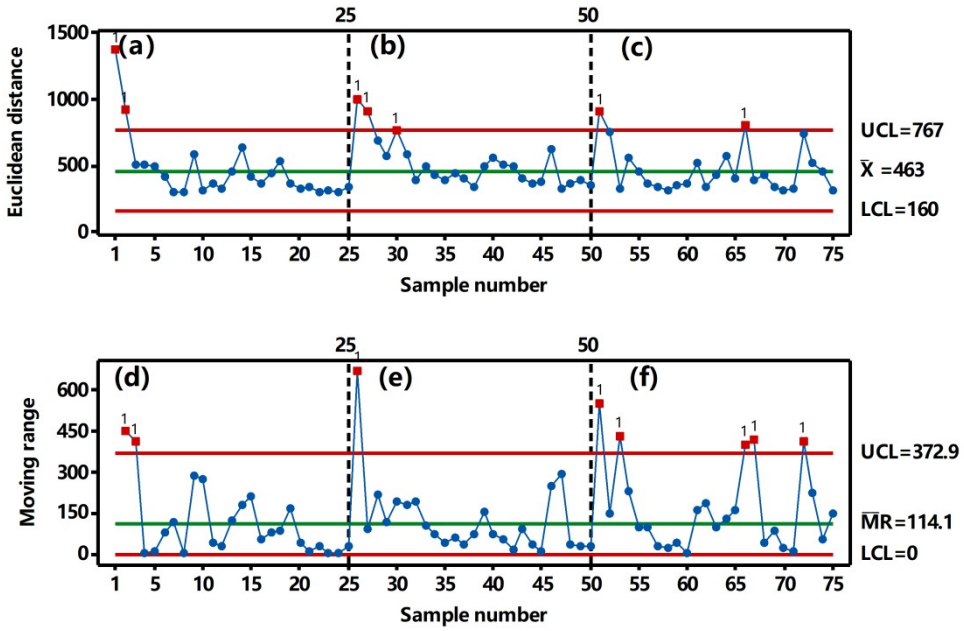

Figure S3 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3

(c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 30 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

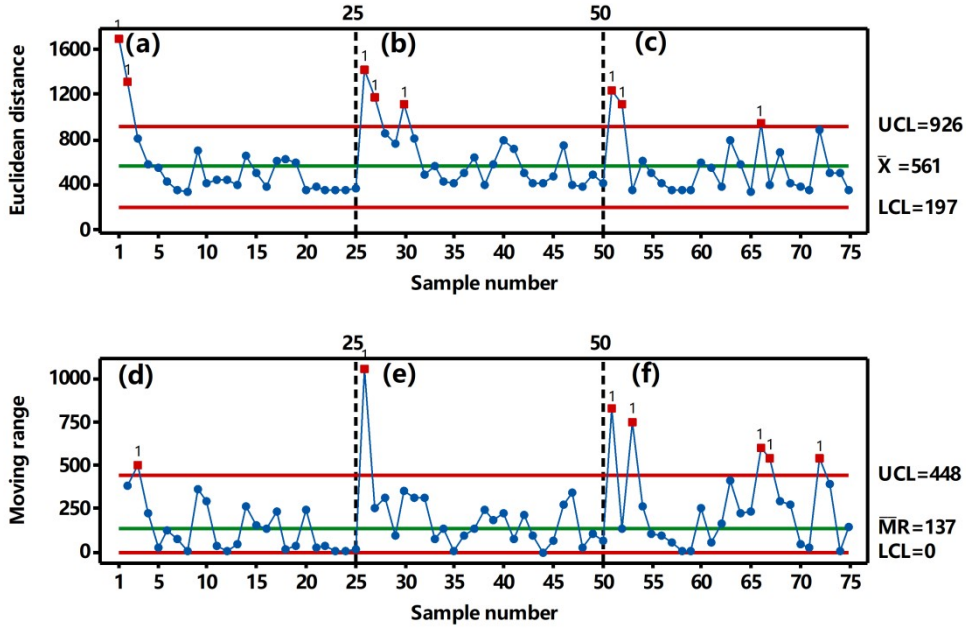

Figure S4 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 40 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

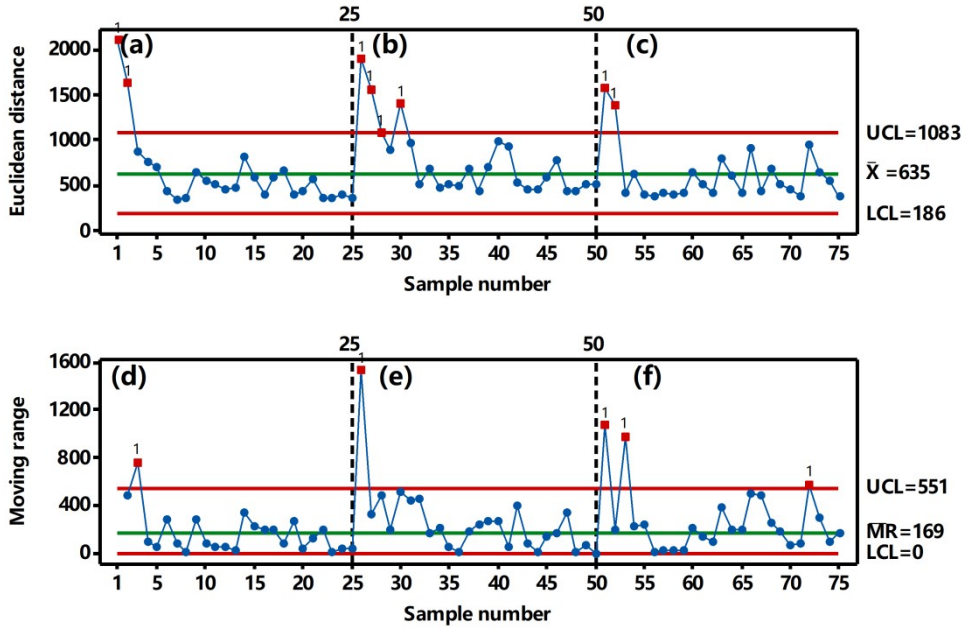

Figure S5 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 50 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

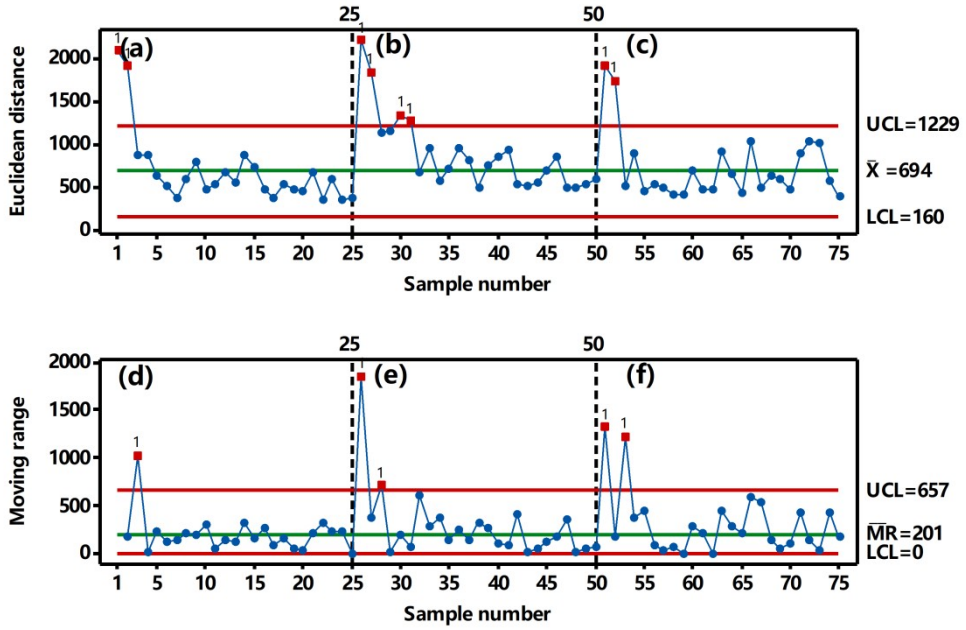

Figure S6 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation

results of Raman spectral Euclidean distance (integration time: 60 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

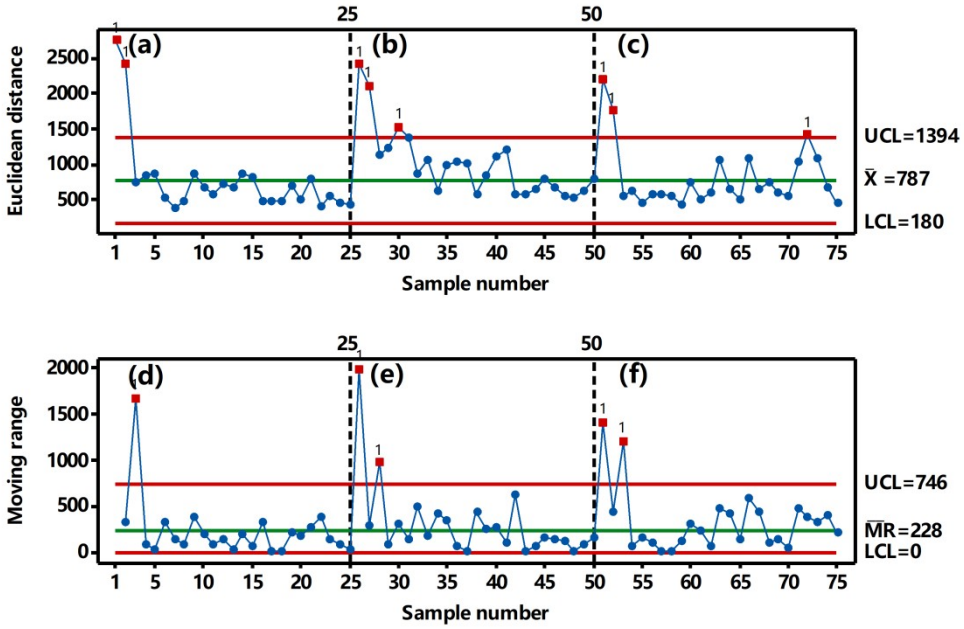

Figure S7 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 70 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

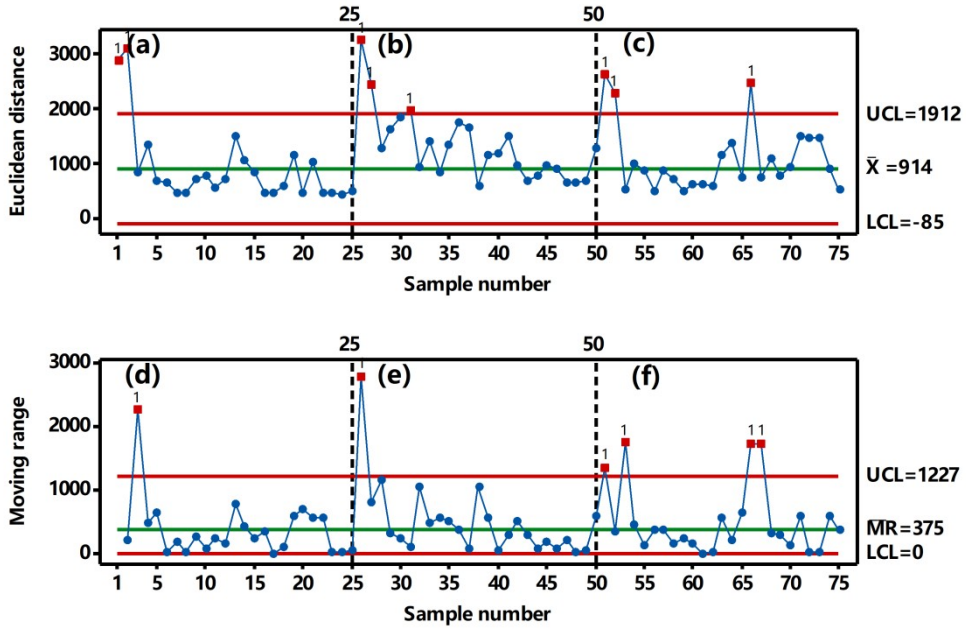

Figure S8 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation results of Raman spectral Euclidean distance (integration time: 90 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

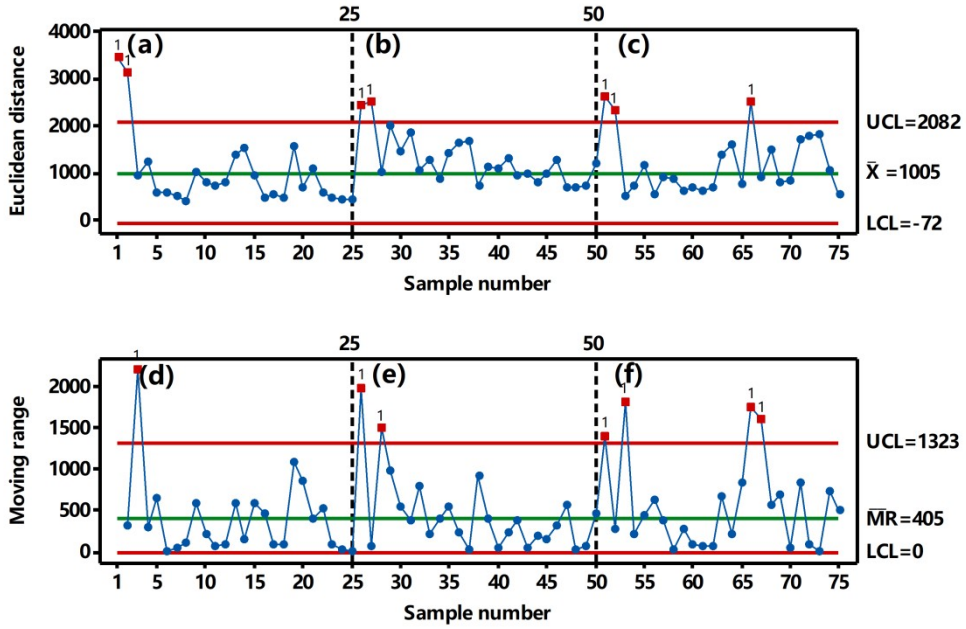

Figure S9 Quality fluctuation individual value of brand 1 (a), brand 2 (b), and brand 3 (c) and moving range of brand 1 (d), brand 2 (e), and brand 3 (f) based on calculation

results of Raman spectral Euclidean distance (integration time: 100 s), respectively. UCL=upper control limit; LCL=lower control limit; $\overline{MR}$ =the average value of moving range control chart. $\bar{x}$ =the average value of individual control chart.

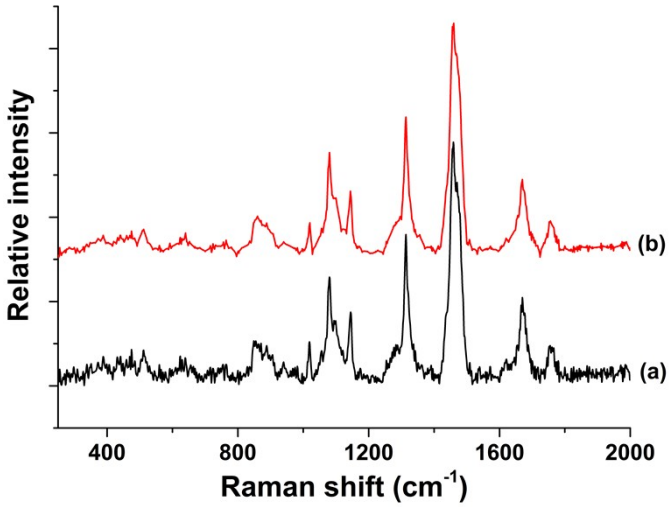

Figure S10 (a) Original Raman spectrum (b) after wavelet denoising of brand 1 (integration time: 80 s).

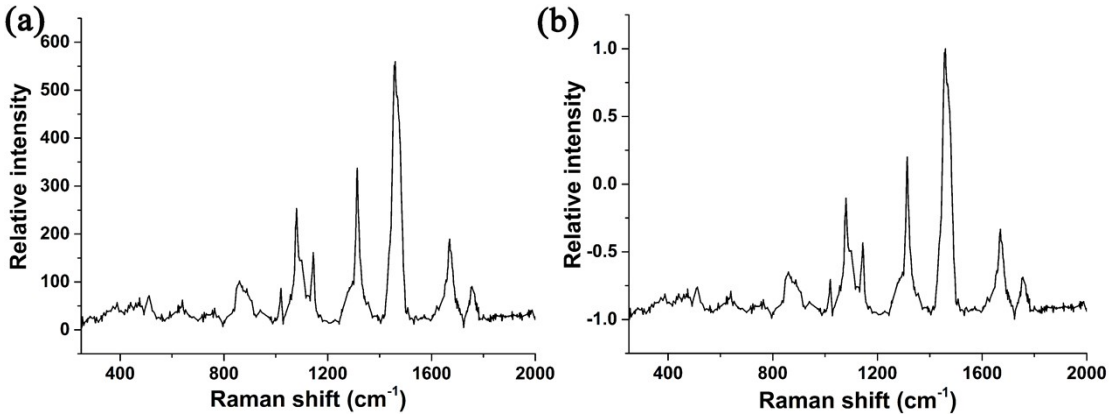

Figure S11 (a) Raman spectrum after wavelet denoising (b) normalized spectrum of brand 1 (integration time: 80 s).

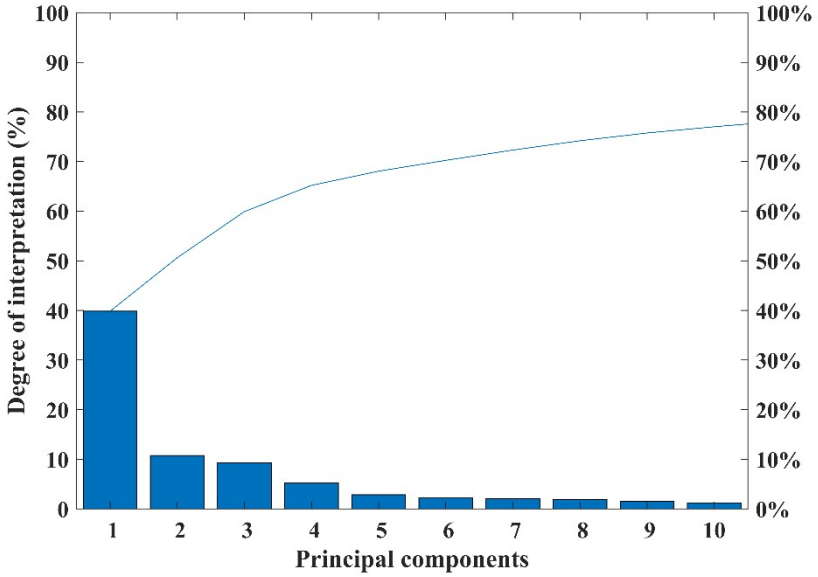

Figure S12 Pareto diagram of dimension reduction results of principal component analysis.

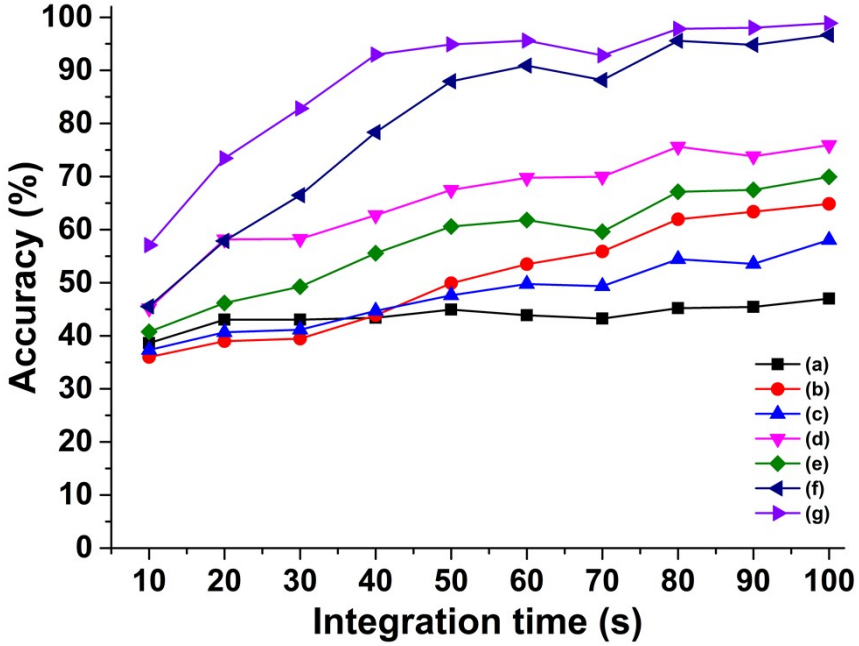

Figure S13 The recognition results are based on (a) original spectrum, (b) wavelet denoising, (c) normalization (d) principal component analysis (e) wavelet denoising combined with normalization, (f) normalization combined with principal component analysis (g) wavelet denoising, normalization and principal component analysis. (the number of hidden layer neurons is 250).