

**Table S1.** Changes in physicochemical and microbial properties during kisra fermentation with or without *P. pentosaceus* strains.

| Groups <sup>1</sup> | Physicochemical and microbial properties | Processing stages         |                           |                           |                          |                           |                           |                          |
|---------------------|--|---------------------------|---------------------------|---------------------------|--------------------------|---------------------------|---------------------------|--------------------------|
|                     |  | First fermentation        |                           |                           | Second fermentation      |                           |                           | Baked                    |
|                     |  | 0 h                       | 24 h                      | 48 h                      | 0 h                      | 6 h                       | 12 h                      | kisra                    |
| Blank group         | LAB count (log CFU/g)                    | ND <sup>2</sup>           | ND                        | ND                        | ND                       | ND                        | ND                        | ND                       |
|                     | pH                                       | 6.89±0.01 <sup>3,a</sup>  | 6.90±0.01 <sup>a</sup>    | 6.89±0.01 <sup>a</sup>    | 6.91±0.01 <sup>a</sup>   | 6.91±0.01 <sup>a</sup>    | 6.91±0.01 <sup>a</sup>    | 6.83±0.01 <sup>b</sup>   |
|                     | a <sub>w</sub>                           | 0.988±0.001 <sup>b</sup>  | 0.988±0.001 <sup>b</sup>  | 0.988±0.001 <sup>b</sup>  | 0.991±0.001 <sup>a</sup> | 0.991±0.001 <sup>a</sup>  | 0.991±0.001 <sup>a</sup>  | 0.978±0.001 <sup>c</sup> |
|                     | TTA (%) <sup>4</sup>                     | 0.13±0.01 <sup>b</sup>    | 0.13±0.02 <sup>b</sup>    | 0.12±0.01 <sup>b</sup>    | 0.13±0.01 <sup>b</sup>   | 0.13±0.02 <sup>b</sup>    | 0.13±0.02 <sup>b</sup>    | 0.24±0.01 <sup>a</sup>   |
| Control group       | LAB count (log CFU/g)                    | 6.00±0.08 <sup>c</sup>    | 9.12±0.21 <sup>a</sup>    | 9.06±0.09 <sup>a</sup>    | 7.93±0.05 <sup>b</sup>   | 9.13±0.00 <sup>a</sup>    | 9.19±0.01 <sup>a</sup>    | ND <sup>d</sup>          |
|                     | pH                                       | 7.03±0.01 <sup>a</sup>    | 4.28±0.36 <sup>b</sup>    | 3.76±0.05 <sup>b</sup>    | 6.15±0.04 <sup>a</sup>   | 3.98±0.02 <sup>b</sup>    | 3.78±0.00 <sup>b</sup>    | 3.64±0.00 <sup>b</sup>   |
|                     | a <sub>w</sub>                           | 0.987±0.000 <sup>a</sup>  | 0.987±0.002 <sup>a</sup>  | 0.983±0.004 <sup>a</sup>  | 0.984±0.004 <sup>a</sup> | 0.984±0.000 <sup>a</sup>  | 0.985±0.000 <sup>a</sup>  | 0.973±0.002 <sup>b</sup> |
|                     | TTA (%) <sup>4</sup>                     | 0.15±0.01 <sup>c</sup>    | 0.89±0.17 <sup>cd</sup>   | 1.28±0.03 <sup>b</sup>    | 0.23±0.00 <sup>c</sup>   | 0.80±0.06 <sup>d</sup>    | 1.02±0.03 <sup>c</sup>    | 1.98±0.00 <sup>a</sup>   |
| K-B21 group         | LAB count (log CFU/g)                    | 7.33±0.08 <sup>c</sup>    | 9.00±0.00 <sup>ab</sup>   | 8.37±0.13 <sup>c</sup>    | 7.59±0.10 <sup>d</sup>   | 8.91±0.03 <sup>b</sup>    | 9.12±0.08 <sup>a</sup>    | ND <sup>f</sup>          |
|                     | pH                                       | 6.85±0.05 <sup>a</sup>    | 3.87±0.01 <sup>c</sup>    | 3.79±0.00 <sup>f</sup>    | 6.08±0.03 <sup>b</sup>   | 4.40±0.02 <sup>c</sup>    | 3.99±0.00 <sup>d</sup>    | 3.82±0.01 <sup>ef</sup>  |
|                     | a <sub>w</sub>                           | 0.988±0.007 <sup>a</sup>  | 0.991±0.002 <sup>a</sup>  | 0.985±0.002 <sup>ab</sup> | 0.990±0.004 <sup>a</sup> | 0.984±0.000 <sup>ab</sup> | 0.981±0.001 <sup>bc</sup> | 0.975±0.000 <sup>c</sup> |
|                     | TTA (%)                                  | 0.10±0.00 <sup>c</sup>    | 0.88±0.05 <sup>b</sup>    | 0.86±0.08 <sup>b</sup>    | 0.14±0.00 <sup>c</sup>   | 0.47±0.05 <sup>d</sup>    | 0.72±0.03 <sup>c</sup>    | 1.38±0.01 <sup>a</sup>   |
| K-B01 group         | LAB count (log CFU/g)                    | 6.88±0.14 <sup>c</sup>    | 9.05±0.04 <sup>c</sup>    | 8.39±0.04 <sup>ab</sup>   | 8.08±0.88 <sup>b</sup>   | 9.00±0.033 <sup>a</sup>   | 9.08±0.03 <sup>a</sup>    | ND <sup>d</sup>          |
|                     | pH                                       | 6.88±0.00 <sup>a</sup>    | 3.85±0.00 <sup>c</sup>    | 3.80±0.00 <sup>f</sup>    | 6.08±0.01 <sup>b</sup>   | 4.40±0.04 <sup>c</sup>    | 4.00±0.01 <sup>d</sup>    | 3.81±0.01 <sup>ef</sup>  |
|                     | a <sub>w</sub>                           | 0.988±0.006 <sup>ab</sup> | 0.986±0.003 <sup>ab</sup> | 0.987±0.001 <sup>ab</sup> | 0.989±0.001 <sup>a</sup> | 0.984±0.001 <sup>ab</sup> | 0.983±0.003 <sup>ab</sup> | 0.979±0.010 <sup>b</sup> |
|                     | TTA (%)                                  | 0.09±0.00 <sup>c</sup>    | 0.85±0.03 <sup>bc</sup>   | 0.90±0.03 <sup>b</sup>    | 0.14±0.00 <sup>c</sup>   | 0.48±0.03 <sup>d</sup>    | 0.71±0.05 <sup>c</sup>    | 1.57±0.14 <sup>a</sup>   |

<sup>1</sup> Blank group (kisra non-fermented), control group (kisra naturally fermented without an inoculum), K-B21 group (kisra fermented with *P. pentosaceus* K-B21), K-B01 group (kisra fermented with *P. pentosaceus* K-B01).

<sup>2</sup> ND: not detected.

<sup>3</sup> Data represented as mean±standard deviation from triplicate measurements. Values in the same row followed by different letters (a-f) are significantly different ( $p < 0.05$ ).

<sup>4</sup> Total titratable acidity expressed as lactic acid percentage.

**Table S2.** Changes in biogenic amine content during kiswa fermentation with or without *P. pentosaceus* strains.

| Groups <sup>1</sup> | Processing stages   |       | Biogenic amine content (mg/kg) <sup>2</sup> |     |                           |                          |                          |                         |                          |                         |
|---------------------|---------------------|-------|---|-----|---------------------------|--------------------------|--------------------------|-------------------------|--------------------------|-------------------------|
|                     |                     |       | TRP   | PHE | PUT                       | CAD                      | HIS                      | TYR                     | SPD                      | SPM                     |
| Blank group         | First Fermentation  | 0 h   | ND <sup>3</sup>                             | ND  | 2.23±0.17 <sup>4,ab</sup> | ND                       | 3.95±0.23 <sup>a</sup>   | ND                      | 5.16±0.05 <sup>c</sup>   | 5.95±0.10 <sup>c</sup>  |
|                     |                     | 24 h  | ND  | ND  | 2.17±0.08 <sup>b</sup>    | ND                       | 3.61±0.08 <sup>b</sup>   | ND                      | 5.10±0.03 <sup>c</sup>   | 5.95±0.04 <sup>c</sup>  |
|                     |                     | 48 h  | ND  | ND  | 2.18±0.04 <sup>b</sup>    | ND                       | 3.68±0.13 <sup>ab</sup>  | ND                      | 5.09±0.01 <sup>c</sup>   | 5.99±0.06 <sup>c</sup>  |
|                     | Second Fermentation | 0 h   | ND  | ND  | 1.82±0.09 <sup>c</sup>    | ND                       | 3.05±0.09 <sup>c</sup>   | ND                      | 5.79±0.02 <sup>b</sup>   | 6.47±0.12 <sup>b</sup>  |
|                     |                     | 6 h   | ND  | ND  | 1.61±0.21 <sup>c</sup>    | ND                       | 3.11±0.13 <sup>c</sup>   | ND                      | 5.80±0.04 <sup>b</sup>   | 6.42±0.09 <sup>b</sup>  |
|                     |                     | 12 h  | ND  | ND  | 1.67±0.16 <sup>c</sup>    | ND                       | 3.12±0.05 <sup>c</sup>   | ND                      | 5.79±0.01 <sup>b</sup>   | 6.33±0.16 <sup>b</sup>  |
|                     | Baked               | kiswa | ND  | ND  | 2.52±0.06 <sup>a</sup>    | ND                       | 3.35±0.18 <sup>bc</sup>  | ND                      | 6.80±0.04 <sup>a</sup>   | 8.16±0.21 <sup>a</sup>  |
| Control group       | First Fermentation  | 0 h   | ND  | ND  | 2.32±0.44 <sup>d</sup>    | ND <sup>c</sup>          | 2.00±0.43 <sup>d</sup>   | ND <sup>g</sup>         | 7.38±1.55 <sup>b</sup>   | 4.65±0.11 <sup>cd</sup> |
|                     |                     | 24 h  | ND  | ND  | 96.00±4.78 <sup>b</sup>   | 135.08±6.08 <sup>b</sup> | 4.16±0.05 <sup>c</sup>   | 42.40±0.63 <sup>b</sup> | 7.60±0.46 <sup>b</sup>   | 3.24±0.14 <sup>c</sup>  |
|                     |                     | 48 h  | ND  | ND  | 127.81±24.38 <sup>a</sup> | 158.45±9.73 <sup>a</sup> | 39.68±0.47 <sup>a</sup>  | 68.21±1.28 <sup>a</sup> | 8.02±0.22 <sup>b</sup>   | 3.89±0.59 <sup>de</sup> |
|                     | Second Fermentation | 0 h   | ND  | ND  | 13.34±0.23 <sup>cd</sup>  | 12.58±0.61 <sup>d</sup>  | 2.24±1.21 <sup>d</sup>   | 6.64±0.69 <sup>f</sup>  | 6.82±0.23 <sup>b</sup>   | 4.77±0.15 <sup>cd</sup> |
|                     |                     | 6 h   | ND  | ND  | 17.02±1.08 <sup>cd</sup>  | 15.08±0.85 <sup>cd</sup> | 4.18±0.17 <sup>c</sup>   | 17.65±0.44 <sup>c</sup> | 7.01±1.12 <sup>b</sup>   | 5.16±0.03 <sup>c</sup>  |
|                     |                     | 12 h  | ND  | ND  | 14.53±1.15 <sup>cd</sup>  | 15.31±2.91 <sup>cd</sup> | 4.08±0.10 <sup>c</sup>   | 8.55±0.49 <sup>e</sup>  | 7.23±0.56 <sup>b</sup>   | 7.71±0.20 <sup>b</sup>  |
|                     | Baked               | kiswa | ND  | ND  | 25.40±5.18 <sup>c</sup>   | 25.68±0.78 <sup>c</sup>  | 7.78±0.81 <sup>b</sup>   | 12.39±0.03 <sup>c</sup> | 10.46±0.04 <sup>a</sup>  | 9.42±1.18 <sup>a</sup>  |
| K-B21 group         | First Fermentation  | 0 h   | ND  | ND  | 2.01±0.17 <sup>a</sup>    | ND                       | 4.72±0.17 <sup>ab</sup>  | ND                      | 5.01±0.22 <sup>de</sup>  | 5.03±0.55 <sup>a</sup>  |
|                     |                     | 24 h  | ND  | ND  | 2.57±0.50 <sup>a</sup>    | ND                       | 3.39±0.10 <sup>bc</sup>  | ND                      | 4.80±0.10 <sup>e</sup>   | 2.32±0.02 <sup>b</sup>  |
|                     |                     | 48 h  | ND  | ND  | 2.95±0.28 <sup>a</sup>    | ND                       | 3.24±0.36 <sup>c</sup>   | ND                      | 5.51±0.51 <sup>cde</sup> | 2.07±0.91 <sup>b</sup>  |
|                     | Second Fermentation | 0 h   | ND  | ND  | 1.46±0.03 <sup>a</sup>    | ND                       | 3.81±0.06 <sup>abc</sup> | ND                      | 6.06±0.30 <sup>cd</sup>  | 5.38±0.33 <sup>a</sup>  |
|                     |                     | 6 h   | ND  | ND  | 1.69±0.29 <sup>a</sup>    | ND                       | 3.88±0.16 <sup>abc</sup> | ND                      | 6.56±0.73 <sup>bc</sup>  | 4.48±0.53 <sup>a</sup>  |
|                     |                     | 12 h  | ND  | ND  | 1.46±2.06 <sup>a</sup>    | ND                       | 5.05±0.51 <sup>a</sup>   | ND                      | 7.49±0.32 <sup>b</sup>   | 2.60±0.08 <sup>b</sup>  |
|                     | Baked               | kiswa | ND  | ND  | 2.66±0.98 <sup>a</sup>    | ND                       | 5.11±1.36 <sup>a</sup>   | ND                      | 9.50±0.79 <sup>a</sup>   | 4.24±0.68 <sup>a</sup>  |
| K-B01 group         | First Fermentation  | 0 h   | ND  | ND  | 2.00±0.29 <sup>bcd</sup>  | ND                       | 5.10±0.23 <sup>a</sup>   | ND                      | 5.01±0.30 <sup>de</sup>  | 2.67±0.21 <sup>bc</sup> |
|                     |                     | 24 h  | ND  | ND  | 3.02±0.16 <sup>a</sup>    | ND                       | 3.89±0.16 <sup>bc</sup>  | ND                      | 4.89±0.53 <sup>c</sup>   | 2.07±0.01 <sup>c</sup>  |
|                     |                     | 48 h  | ND  | ND  | 2.92±0.12 <sup>a</sup>    | ND                       | 3.16±0.19 <sup>c</sup>   | ND                      | 5.70±1.09 <sup>cde</sup> | 1.70±0.27 <sup>c</sup>  |
|                     | Second Fermentation | 0 h   | ND  | ND  | 1.50±0.15 <sup>d</sup>    | ND                       | 3.96±0.19 <sup>bc</sup>  | ND                      | 6.14±0.03 <sup>bcd</sup> | 4.83±0.50 <sup>a</sup>  |
|                     |                     | 6 h   | ND  | ND  | 2.06±0.19 <sup>bc</sup>   | ND                       | 4.10±0.63 <sup>bc</sup>  | ND                      | 7.00±0.10 <sup>ab</sup>  | 3.48±1.05 <sup>b</sup>  |
|                     |                     | 12 h  | ND  | ND  | 1.96±0.40 <sup>cd</sup>   | ND                       | 4.46±0.57 <sup>ab</sup>  | ND                      | 6.77±0.53 <sup>abc</sup> | 2.21±0.15 <sup>c</sup>  |
|                     | Baked               | kiswa | ND  | ND  | 2.53±0.11 <sup>ab</sup>   | ND                       | 5.32±0.59 <sup>a</sup>   | ND                      | 7.90±0.10 <sup>a</sup>   | 3.67±0.14 <sup>b</sup>  |

<sup>1</sup> Blank group (kiswa non-fermented), control group (kiswa naturally fermented without an inoculum), K-B21 group (kiswa fermented with *P. pentosaceus* K-B21), K-B01 group (kiswa fermented with *P. pentosaceus* K-B01).

<sup>2</sup> TRP: tryptamine; PHE: β-phenylethylamine; PUT: putrescine; CAD: cadaverine; HIS: histamine; TYR: tyramine; SPD: spermidine; SPM: spermine.

<sup>3</sup> ND: not detected.

<sup>4</sup> Data represented as mean±standard deviation from triplicate measurements. Values in the same column of the same group followed by different letters (a-g) are significantly different (*p* < 0.05).

**Table S3.** Changes in antioxidant indices during kisra fermentation with or without *P. pentosaceus* strains.

| Groups <sup>1</sup> | Processing stages   |       | Antioxidant indices       |                              |
|---------------------|---------------------|-------|---------------------------|------------------------------|
|                     |                     |       | DPPH (%)                  | TPC (µg/g) <sup>2</sup>      |
| Blank group         | First Fermentation  | 0 h   | 70.88±0.87 <sup>3,b</sup> | 1325.10±19.72 <sup>bc</sup>  |
|                     |                     | 24 h  | 70.93±0.83 <sup>b</sup>   | 1337.73±16.67 <sup>bc</sup>  |
|                     |                     | 48 h  | 70.70±0.94 <sup>b</sup>   | 1341.37±11.30 <sup>b</sup>   |
|                     | Second Fermentation | 0 h   | 70.74±0.74 <sup>b</sup>   | 1321.17±25.42 <sup>bc</sup>  |
|                     |                     | 6 h   | 70.52±0.47 <sup>b</sup>   | 1309.62±19.82 <sup>c</sup>   |
|                     |                     | 12 h  | 70.22±0.59 <sup>b</sup>   | 1319.64±18.61 <sup>bc</sup>  |
|                     | Baked               | kisra | 74.47±0.65 <sup>a</sup>   | 1522.24±19.81 <sup>a</sup>   |
| Control group       | First Fermentation  | 0 h   | 71.00±7.10 <sup>b</sup>   | 1230.60±58.20 <sup>c</sup>   |
|                     |                     | 24 h  | 83.67±0.50 <sup>a</sup>   | 1301.20±49.90 <sup>bc</sup>  |
|                     |                     | 48 h  | 80.50±2.60 <sup>a</sup>   | 1395.30±8.30 <sup>b</sup>    |
|                     | Second Fermentation | 0 h   | 77.83±0.20 <sup>ab</sup>  | 1274.70±37.40 <sup>bc</sup>  |
|                     |                     | 6 h   | 80.17±2.60 <sup>a</sup>   | 1312.90±74.90 <sup>bc</sup>  |
|                     |                     | 12 h  | 81.67±0.50 <sup>a</sup>   | 1257.10±112.30 <sup>bc</sup> |
|                     | Baked               | kisra | 83.17±1.20 <sup>a</sup>   | 1977.60±25.00 <sup>a</sup>   |
| K-B21 group         | First Fermentation  | 0 h   | 72.50±0.20 <sup>c</sup>   | 1321.80±4.02 <sup>b</sup>    |
|                     |                     | 24 h  | 79.33±0.00 <sup>ab</sup>  | 1233.50±45.80 <sup>b</sup>   |
|                     |                     | 48 h  | 79.33±2.80 <sup>ab</sup>  | 1248.20±83.20 <sup>b</sup>   |
|                     | Second Fermentation | 0 h   | 77.67±4.20 <sup>bc</sup>  | 1230.60±66.60 <sup>b</sup>   |
|                     |                     | 6 h   | 79.00±3.30 <sup>ab</sup>  | 1233.50±54.10 <sup>b</sup>   |
|                     |                     | 12 h  | 83.17±0.70 <sup>a</sup>   | 1342.40±25.00 <sup>b</sup>   |
|                     | Baked               | kisra | 84.17±0.20 <sup>a</sup>   | 1851.20±70.70 <sup>a</sup>   |
| K-B01 group         | First Fermentation  | 0 h   | 75.50±0.70 <sup>d</sup>   | 1374.70±4.20 <sup>b</sup>    |
|                     |                     | 24 h  | 82.50±0.20 <sup>ab</sup>  | 1351.20±4.20 <sup>b</sup>    |
|                     |                     | 48 h  | 81.33±0.00 <sup>bc</sup>  | 1162.90±137.30 <sup>c</sup>  |
|                     | Second Fermentation | 0 h   | 74.00±0.94 <sup>d</sup>   | 1145.30±29.10 <sup>c</sup>   |
|                     |                     | 6 h   | 79.67±1.41 <sup>c</sup>   | 1289.40±33.30 <sup>bc</sup>  |
|                     |                     | 12 h  | 81.17±0.70 <sup>bc</sup>  | 1236.50±74.90 <sup>bc</sup>  |
|                     | Baked               | kisra | 83.50±0.20 <sup>a</sup>   | 1880.50±128.90 <sup>a</sup>  |

<sup>1</sup> Blank group (kisra non-fermented), control group (kisra naturally fermented without an inoculum), K-B21 group (kisra fermented with *P. pentosaceus* K-B21), K-B01 group (kisra fermented with *P. pentosaceus* K-B01).

<sup>2</sup> Total phenolic content is expressed as µg of gallic acid equivalent/g of wet samples.

<sup>3</sup> Data represented as mean±standard deviation from triplicate measurements. Values in the same column of the same group followed by different letters (a-d) are significantly different (*p* < 0.05).