

# **Effect of different probiotic fermentations on the quality of hemp seed plant-based yogurt**

Yingjun Zhou<sup>1</sup>, Yifan Xu<sup>1#</sup>, Shuai Song<sup>2</sup>, Sha Zhan<sup>1</sup>, Xiaochun Li<sup>1</sup>, Haixuan Wang<sup>2</sup>,  
Zuohua Zhu<sup>1</sup>, Li Yan<sup>1</sup>, Yuande Peng<sup>1</sup>, Chunliang Xie<sup>1\*</sup>

<sup>1</sup> Institute of Bast Fiber Crops, Chinese Academy of Agricultural Sciences, Changsha 410205, China

<sup>2</sup> Jiangsu junyao Life Technology Development Co., Ltd., Jiangsu 224100, China

\* Correspondence.

E-mail: [xietchunliang@caas.cn](mailto:xietchunliang@caas.cn)

Table S1. Results of volatile flavor components of samples.

| Compound              | Relative Amount |            |             |            | Odor Description                                        |
|-----------------------|-----------------|------------|-------------|------------|---------------------------------------------------------|
|                       | HMD             | HMP        | HMR         | HMC        |                                                         |
| Aldehydes             |                 |            |             |            |                                                         |
| Propanal              | 5.19±0.64%      | 4.67±0.12% | 7.75±0.09%  | 4.34±0.07% | pungent, green grassy                                   |
| Acetaldehyde          | 3.84±0.07%      | 4.28±0.21% | 5.00±0.23%  | 2.93±0.05% | green, slight fruity                                    |
| Hexanal               | 1.85±0.64%      | 3.51±0.07% | 7.01±0.2%   | 3.1±0.17%  | fresh, green, fat, fruity                               |
| (E)-2-Pentenal        | 1.06±0.17%      | 1.76±0.02% | 1.22±0.08%  | 2.08±0.02% | potato, peas                                            |
| 3-Methylbutanal       | 0.50±0.06%      | 0.22±0.01% | 1.00±0.06%  | 0.42±0.01% | chocolate, fat                                          |
| (E)-2-Heptenal        | 0.56±0.06%      | 0.94±0.02% | 0.97±0.06%  | 0.48±0.03% | spicy, green vegetables, fresh, fatty                   |
| (E)-2-Hexenal         | 0.54±0.09%      | 0.86±0.01% | 0.82±0.03%  | 0.48±0.01% | green, banana, fat                                      |
| Pentanal              | 0.11±0.03%      | 0.22±0.01% | 0.90±0.03%  | 0.11±0.01% | green grassy, faint banana, pungent                     |
| 2-Methylbutanal       | 0.40±0.04%      | 0.23±0.03% | 0.61±0.06%  | 0.23±0.01% | almond, cocoa, malt                                     |
| Butanal               | 0.33±0.02%      | 0.29±0.02% | 0.63±0.01%  | 0.20±0.01% | pungent, fruity, green leaf                             |
| (E)-2-Octenal         | 0.22±0.05%      | 0.50±0.01% | 0.21±0.00%  | 0.32±0.01% | fresh cucumber, fatty, green herbal, banana, green leaf |
| 3-Methyl-2-butenal    | 0.35±0.00%      | 0.23±0.01% | 0.24±0.01%  | 0.25±0.01% | fruity                                                  |
| Benzaldehyde          | 0.20±0.02%      | 0.15±0.01% | 0.21±0.02%  | 0.20±0.01% | bitter almond, cherry, nutty                            |
| Heptanal              | 0.21±0.03%      | 0.15±0.01% | 0.26±0.01%  | 0.20±0.01% | fresh, aldehyde, fatty, green herbs, wine, fruity       |
| Nonanal               | 0.12±0.01%      | 0.10±0.02% | 0.12±0.02%  | 0.09±0.01% | rose, citrus, strong oily                               |
| (E,E)-2,4-Heptadienal | 0.13±0.02%      | 0.20±0.02% | 0.17±0.01%  | 0.13±0.01% | fatty, oily, aldehyde, vegetable, cinnamon              |
| 2-Propenal            | 0.09±0.00%      | 0.16±0.01% | 0.12±0.01%  | 0.11±0.00% | strong pungent                                          |
| 2-Methylpropanal      | 0.11±0.01%      | 0.03±0.00% | 0.10±0.01%  | 0.06±0.00% | banana, melon , slightly nutty                          |
| 2-Methyl- 2-pentenal  | 0.05±0.00%      | 0.06±0.00% | 0.07±0.01%  | 0.10±0.01% | aldehydes, soil, garlic, ripe cherries, fruity          |
| alcohol               |                 |            |             |            |                                                         |
| Ethanol               | 15.74±0.32%     | 11.1±0.11% | 11.23±0.16% | 11.69±0.2% | aromaticity                                             |
| 1-Hexanol             | 3.62±0.28%      | 5.93±0.06% | 2.59±0.09%  | 3.31±0.09% | fresh, fruity, wine, sweet, green                       |
| 1-Propanol            | 3.32±0.1%       | 1.44±0.02% | 1.58±0.02%  | 1.84±0.02% | alcohol, pungent                                        |
| 1-Penten-3-ol         | 2.16±0.12%      | 2.44±0.05% | 1.99±0.04%  | 2.97±0.06% | ethereal, green, tropical fruity                        |
| 1-Pentanol            | 1.23±0.08%      | 1.72±0.01% | 1.49±0.03%  | 2.24±0.02% | balsamic                                                |
| 3-Methyl-1-butanol    | 0.97±0.03%      | 0.94±0.01% | 0.82±0.01%  | 0.95±0.02% | whiskey, banana, fruity                                 |
| 1-Butanol             | 0.82±0.05%      | 0.83±0.03% | 0.81±0.02%  | 1.02±0.04% | wine                                                    |
| 2-Propanol            | 0.47±0.03%      | 0.60±0.01% | 0.44±0.02%  | 0.41±0.02% | alcohol, spicy                                          |
| 2-Methyl-1-propanol   | 0.41±0.02%      | 0.63±0.01% | 0.28±0.01%  | 0.37±0.01% | fresh, alcoholic, leather                               |
| 1-Octen-3-ol          | 0.17±0.02%      | 0.29±0.00% | 0.23±0.02%  | 0.29±0.00% | mushroom, lavender, rose, hay                           |
| 1-Heptanol            | 0.12±0.01%      | 0.15±0.01% | 0.14±0.01%  | 0.27±0.01% | grape, fruity, wine, violet, peony                      |
| 3-Methyl-3-buten-1-ol | 0.14±0.00%      | 0.27±0.01% | 0.12±0.01%  | 0.16±0.00% | sweet, fruity                                           |
| 2-Heptanol            | 0.13±0.01%      | 0.17±0.01% | 0.14±0.01%  | 0.10±0.00% | mushroom、melon                                          |
| 2-Butanol             | 0.14±0.00%      | 0.12±0.00% | 0.10±0.01%  | 0.16±0.00% | fruity                                                  |
| 2-Pentanol            | 0.06±0.01%      | 0.07±0.00% | 0.07±0.01%  | 0.13±0.01% | Fusel Oil, Green                                        |
| ketone                |                 |            |             |            |                                                         |
| 2-Propanone           | 8.43±0.47%      | 8.81±0.14% | 8.86±0.13%  | 8.51±0.14% | fresh, apple, pear                                      |
| 3-Hydroxy-2-butanone  | 4.87±0.2%       | 6.49±0.13% | 3.87±0.1%   | 4.4±0.19%  | fatty, oily, aldehyde, vegetable, cinnamon              |
| 2-Pentanone-D         | 3.70±0.39%      | 4.07±0.05% | 3.71±0.07%  | 5.16±0.04% | acetone, fresh, sweet fruity, wine                      |
| 2-Butanone            | 3.27±0.18%      | 3.26±0.05% | 4.96±0.08%  | 4.62±0.17% | fruity , camphor                                        |
| 2,3-Butanedione       | 1.15±0.09%      | 1.26±0.02% | 1.45±0.07%  | 0.71±0.02% | butter, popcorn, sweet taste, sour rice                 |
| 2-Heptanone-M         | 1.22±0.06%      | 0.78±0.12% | 1.64±0.02%  | 0.18±0.00% | pear, banana, fruity, slight medicinal fragrance        |
| 1-Penten-3-one        | 0.36±0.04%      | 0.79±0.02% | 0.24±0.01%  | 0.29±0.01% | strong pungent odors                                    |
| 2-Hexanone            | 0.35±0.01%      | 0.32±0.01% | 0.33±0.01%  | 0.25±0.00% | fruity, fungal, meaty, buttery                          |
| 2,3-Pentanedione      | 0.26±0.02%      | 0.25±0.03% | 0.28±0.01%  | 0.28±0.02% | sweet, cream, caramel, nuts, cheese                     |
| 4-Methyl 2-pentanone  | 0.25±0.02%      | 0.25±0.01% | 0.23±0.00%  | 0.24±0.02% | ketone                                                  |
| 2-Nonanone            | 0.07±0.01%      | 0.07±0.01% | 0.08±0.01%  | 0.16±0.01% | fresh, sweet, green, herb                               |
| alkene                |                 |            |             |            |                                                         |
| Myrcene               | 0.16±0.02%      | 0.25±0.00% | 0.15±0.01%  | 0.35±0.01% | must, spice, balsamic                                   |

|                        |             |             |             |             |                                                                 |
|------------------------|-------------|-------------|-------------|-------------|-----------------------------------------------------------------|
| 3-Carene               | 0.12±0.01%  | 0.15±0.02%  | 0.10±0.01%  | 0.13±0.00%  | citrus, lemon, woody                                            |
| beta-Pinene            | 0.05±0.00%  | 0.07±0.00%  | 0.04±0.00%  | 0.26±0.01%  | resin, green                                                    |
| <b>ester</b>           |             |             |             |             |                                                                 |
| Ethyl acetate          | 9.24±0.89%  | 6.88±0.5%   | 8.55±0.12%  | 9.34±1.2%   | fresh, fruity, sweet, grassy                                    |
| Ethyl butanoate        | 0.30±0.03%  | 0.31±0.01%  | 0.38±0.01%  | 0.30±0.01%  | pineapple, fruity, ester, whiskey                               |
| cis-3-Hexenyl acetate  | 0.08±0.01%  | 0.05±0.01%  | 0.06±0.01%  | 0.06±0.01%  | fresh green grassyy, sweet, fruity, banana                      |
| <b>carboxylic acid</b> |             |             |             |             |                                                                 |
| Acetic acid            | 16.29±1.05% | 17.43±0.07% | 12.32±0.36% | 19.22±0.57% | spicy                                                           |
| Propanoic acid         | 0.47±0.03%  | 0.51±0.02%  | 0.53±0.04%  | 0.54±0.02%  | yogurt, vinegar                                                 |
| <b>sulfide</b>         |             |             |             |             |                                                                 |
| Dimethyl sulfide       | 2.05±0.09%  | 0.80±0.05%  | 0.79±0.15%  | 1.09±0.05%  | cabbage, sulfur, gasoline                                       |
| Dimethyl disulfide     | 0.02±0.00%  | 0.04±0.00%  | 0.05±0.01%  | 0.05±0.01%  | sulfurous , cabbage, onion                                      |
| <b>furan</b>           |             |             |             |             |                                                                 |
| 2-Pentylfuran          | 0.06±0.01%  | 0.15±0.01%  | 0.06±0.01%  | 0.18±0.01%  | bean, fruity, earthy, green, vegetable                          |
| <b>Others</b>          |             |             |             |             |                                                                 |
| Ethylbenzene           | 0.11±0.00%  | 0.12±0.01%  | 0.12±0.03%  | 0.24±0.02%  | Aromatic odor                                                   |
| 2-Ethylpyrazine        | 0.11±0.01%  | 0.11±0.00%  | 0.09±0.01%  | 0.09±0.01%  | nutty, mouldy, woody, potato, earthy, roast, meat, fishy, cocoa |
| 1,8-Cineole            | 0.08±0.01%  | 0.1±0.01%   | 0.09±0.00%  | 0.06±0.00%  | camphor, refreshing herbal                                      |