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Technical Variables Influencing to Pickling from *Sesbania grandiflora* Flower

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Sesbania grandiflora flower was rich in nutrients and antioxidant activities. There's a great consumption demand from this valuable flower for cuisine in fresh or processed forms. It's highly perishable under the prevailing conditions due to hot temperature and low humidity as well as lack of adequate storage facilities. Pickling could be considered as an alternative for processing the flower into a value-added product. This research evaluated the influence of salt: sugar medium and *L. acidophilus* inoculation ratio to the accumulation of total phenolics and flavonoids during pickling of *Sesbania grandiflora* flower. This flower was primarily blanched with hot water solution containing 0.15% citric acid at 100°C for 15 seconds to inactivate internal enzymatic reaction as well as microbial inactivation. Then it was fermented in fermentation tank with different formula of salt: sugar (12%: 3%, 9%:6%, 6%:9%, 3%:12%) as pickling medium and various inoculation ratio (1, 2, 3, 4 mL by density (10^9 CFU/mL) of *L. acidophilus* at ambient temperature for 3 days. Total phenolic content (mg GAE/ 100g) and total flavonoid content (mg QE/ 100g) were used as reflective indicators of fermentation efficacy. Results showed that 9%:6% (salt: sugar) and 3 mL of *L. acidophilus* 10^9 CFU/mL were appropriate for pickling. Pickled *Sesbaniagrandiflora* flower by lactic acid fermentation had unique flavor and great healthful advantage.

Keywords: ***: L. acidophilus*, *flavonoids, phenolics, pickling, salt: sugar concentration, Sesbania grandiflora flower***

INTRODUCTION

Sesbania grandiflora was a medicinal plant belonging to family Leguminosae. Major nutrients and phytochemical components containing inside *Sesbania grandiflora* flower were soluble sugars, proteins, vitamins, minerals, alkaloids, flavonoids, glycosides, tannin, sovestitol, medicarpin, anthraquinone, steroid, pholobatannins, and terpenoids (Shyamala and Vasantha, 2010; Suresh and Sanjay, 2012; RejiandRexin, 2017). They were responsible for antibacterial, anti-plaque, antifungal, antioxidant, anti-urolithiatic, anticonvulsant, anxiolytic, anticancer, antiproliferative and hepatoprotective attributes (Roy et al.2013;Sankar et al. 2014; Saifudin et.al, 2016; Janani and Aruna, 2017; Abdu, 2019). Extract of *Sesbania grandiflora*was potential to be used as a remedy for thrombosis, diarrhea, inflammatory, bronchitis, cough, vomiting, wounds ulcers, diarrhea, dysentery, rheumatic swelling, nasal catarrah, nyctalopia and cephalagia, colic disorder, jaundice, poisoning, small-pox, eruptive fever, epilepsy, nightbliness, cataract and headache (China et al. 2012; Suresh and Sanjay, 2012; Bhoumik et al. 2016; Arfan et al. 2016a; Arfan et al. 2016b; Chung et al. 2016; Das et al. 2017; Janani and Aruna, 2017). The flowers of *Sesbania grandiflora* were borne on an unbranched, pendulous inflorescence. Two varieties of *Sesbania grandiflora* L. included large white yellowish and pink flowers (Mukul et al. 2012; Abbs and Rexin, 2013). White flower variety of *S. grandiflora* found to be non-toxic, the purple flower type was highly toxic (Abdul, 2019).

Quercetin, myricetin and kaempferol were the main chemical components of flower (Mustafa et al. 2010; Sangeetha et al. 2014;). The flowers had an excellent source of vitamins and minerals. Its flower was heartily used in cuisine as delicious soup, fritters (Janani and Aruna, 2017). Objective of our study evaluated the influence of salt: sugar medium and *L. acidophilus* inoculation ratio to the accumulation of total phenolics and flavonoids during pickling of *Sesbania grandiflora* flower

MATERIALS AND METHODS

Material

The flower samples of *S. grandiflora* were collected from gardens in SocTrang province, Vietnam. *L. acidophilus* was cultured in flasks under CO_2 enriched condition at 37 °C for 24h in MRS broth before lactic fermentation for *S. grandiflora* flower.

Researching method

Salt-sugar solutions were prepared in different formulas (12% salt + 3% sugar, 9% salt + 6% sugar; 6% salt + 9% sugar; 3% salt + 12% sugar). *S. grandiflora* flowers were primarily blanched in hot water solution with 0.15% acid citric at 100°C for 15 seconds. *L. acidophilus* culture (1, 2, 3, 4 mL containing 10^9 CFU/mL) was added into fermention tanks with salt-sugar pickling solutions prepared in advance. The fermentation process was conducted at ambient for 3 days.

Physicochemical determination

The total phenolic content (mg GAE/100g) was evaluated according to the method described by Siddhuraju and Becker (2003).Total flavonoid content (mg QE/ 100g) was measured by the aluminum chloride colorimetric assay (Ebrahinzadeh et al. 2008).

Statistical analysis

The experiments were run in 594 samples with 9 different groups of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI..

RESULTSAND DISCUSSION

In our experiment, the blanched *S. grandiflora* flowers were submered in different pickling medium formulas (12% salt + 3% sugar, 9% salt + 6% sugar; 6% salt + 9% sugar; 3% salt + 12% sugar). The pickling process was performed with 1 mL of *L. acidophilus* culture (10^9 CFU/mL) at ambient temperature for 3 days. It was clearly noticed that 9% salt + 6% sugar created a favorable condition for *L. acidophilus* growth to produce abundant phenolic and flavonoid (table 1). Blanching was necessary to inactivate internal enzymes and harmful pathogen. Blanching was popularly applied in the food processing of green leafy vegetables (Prakash et al. 2018). Salt was essential as it enhanced the preservative, technological and sensory food attributes (Brady, 2002). Appropriate salt concentration created effective fermentation by favoring lactic acid bacteria and inhibiting salt-sensitive spoilage bacteria by reducing water activity (Arghya et al. 2017; Erin and Suzanne, 2018). Lactic acid bacteria growth was highly influenced by sugar concentration as substrate for lactic fermentation. The proliferation of the intestinal microflora created a positive barrier against pathogenic bacteria from invading the gastrointestinal tract. The composition of the intestinal microflora together with the gut immune system permitted residential microorganism to exert a protective role (Ratna et al. 2012). Lactobacilli and bifidobacteria were major bacteria positive for human gastrointestinal health. Polyphenols acted as antioxidant and antiradical agent to modulate the oxidative stress in the medium generated by the metabolic activities and consequently provided a better environment for the growth and multiplication of lactic bacteria (Molan et al. 2009). In the human intestine the extensive metabolism of flavonoids attributed to the action of intestinal microflora (Kim et al. 1998).

The pickling process also highly affected by the ratio of culture bacteria. In our research, the pickling process was verified under various culture volume (1, 2, 3, 4 mL) of *L. acidophilus* (10^9 CFU/mL). Our result revealed that there was significant difference of total phenolic and flavonoid formation by incoculation ratio of culture media from 1 to 3 mL. At 3 mL and 4 mL, there was not signiciant difference of total phenolic and flavonoid in the pickle product (table 2). Therefore we could choose 3 mL of *L. acidophilus* (10^9 CFU/mL) for pickling production. Lactic acid fermentation retained almost the natural plant ingredients while improving the quality, taste and aroma. Fermented vegetables contained great sources of natural antioxidants such as vitamins, carotenoids, flavonoids and other phenolic compounds (Takebayashi et al. 2013; Isa-belle et al. 2010).

Table1: Effect of salt % + sugar % in pickling media to total phenolic and flavonoid formation during pickling of *S. grandiflora* flower

Culture medium	Raw flower	12% salt + 3% sugar	9% salt + 6% sugar	6% salt + 12% sugar	3% salt + 12% sugar
Total phenolic (mg GAE/ 100g)	139.24±1.25[d]	206.34±0.82[c]	403.15±2.01[a]	319.60±0.96[b]	267.13±1.03[bc]
Total flavonoid (mg QE/ 100g)	43.75±0.79[c]	53.17±1.17[bc]	97.43±1.45[a]	78.11±0.32[ab]	66.42±1.26[b]

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2: Effect of inoculation ratio of *L. acidophilus* in pickling media to total phenolic and flavonoid formation during pickling of *S. grandiflora* flower

Inoculation ratio (%)	Raw flower	1	2	3	4
Total phenolic (mg GAE/ 100g)	139.24±1.25[c]	403.15±2.01[b]	486.52±2.03[ab]	534.09±1.47[a]	540.34±1.20[a]
Total flavonoid (mg QE/ 100g)	43.75±0.79[c]	97.43±1.45[b]	114.68±1.89[ab]	169.41±2.01[a]	172.95±1.77[a]

Note: the values were expressed as the mean of twenty two samples; the same characters (denoted above), the difference between them was not significant (α = 5%).

S. grandiflora polyphenolic extracts induced a significant biomass increase of *L. acidophilus* grown in liquid culture media (Ratna et al. 2012). *S. grandiflora* flower extract was successfully demonstrated for antimicrobial effect against *Escherichia coli*, *Bacillus cereus* and *Staphylococcus aureus* (Krasaekoopt and Kongkarnchanatip 2005).

CONCLUSION

The *Sesbania grandiflora* flowers had an excellent source of nutritional and phytochemical constituents. Apart from nutritive and pharmacological benefits, *Sesbania grandiflora* flowers was also free from pesticide residue. Pickle from this vegetable could improve added values and reduce post-harvest losses. This research demonstrated that salt: sugar concentration and *L. acidophilus* inoculation ratio and significant impacto to the formation of phenolics and flavonoids as antioxidant useful for human health.

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CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Nguyen Phuoc Minh arranged the experiments and also wrote the manuscript.

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