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ARTICLE

Organoleptic Evaluation of the High-Protein Yoghurt containing the Edible Insect *Oxya chinensis sinuosa* (Grasshopper): A Preliminary Study

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Abstract

This objectives of this study were to assess the pH and titratable acid (TA) and conduct sensory evaluation of the high-protein yogurt supplemented with *Oxya chinensis sinuosa* (grasshopper). High-protein yogurt containing *Oxya chinensis sinuosa* powder displayed TA of 0.93% to 1.1%, and a pH of 4.3 or 4.4. There were no significant differences between the control and treated groups in pH and TA. Organoleptic evaluations revealed that, except for color and texture, taste, flavor, and overall acceptability showed decreased trends in proportion to the amount of *Oxya chinensis sinuosa* powder. Further studies will explore the potential of *Oxya chinensis sinuosa* powder as a protein with health benefits for humans.

Keywords

Oxya chinensis sinuosa (Grasshopper), yoghurt, high-protein, organoleptic evaluation

Introduction

In fact, edible insects known as a high-quality protein source were used as ingredients in many cooking recipes in Asia, Africa, South America, Australia, etc. (FAO, 2013; Kim *et al.*, 2017). In general, most edible insects contained abundant amounts of energy, protein, UFA (unsaturated fatty acid), and trace nutrients such as biotin, copper, iron, magnesium, manganese, and pantothenic acid (Kim *et al.*, 2017). According to FAO projection, the world population would be over 10 billion on 2050. At that time, the production of food would not meet the need of population (FAO, 2009). Hence, recently the attention for preparing the food crisis would be increasing so as to obtain new alternative foods with high protein (Van Huis *et al.*, 2013). Especially, it was widely known as edible insects had the abundant contents in various minerals, vitamins, protein, and so on (Nowak, *et al.*, 2016). Oonincx *et al.* (2010) reported the good effects of edible insects which have the low possibility of environment contamination compared to current livestock food sources as much less greenhouse gas per serving is emitted. Unitl now, edible insects have always been food for human, but there is a degree of distaste for their consumption in some societies (FAO, 2013). Over 2000 species have reportedly been used as diets (FAO, 2013). Among various edible insects, approximately 80 *Oxya chinensis sinuosa* (Grasshopper) species were consumed worldwide, and the large majority of *Oxya chinensis sinuosa* (Grasshopper) species were edible (FAO, 2013).

A among the representative edible insects in South Korea, *Oxya chinensis sinuosa* (Grasshopper) was also included (Ji *et al.*, 2015). The protein concentration of *Oxya chinensis sinuosa* (Grasshopper) was about 742.8 g/kg dry weight, and it meant that edible insects were the valuable resource of dietary protein or of protein supplement (Kim *et al.*, 2017).

Among various dairy foods, yogurt was a popular nutritious food that was widely consumed throughout the world (Lucas-Hattingh *et al.* 2004). The need of dairy products with protein such as bioactive peptides would be increasing so as to meet the daily nutritional requirements (Wang *et al.*, 2017). Hence, the objective of this study was to produce the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) for improving Organoleptic evaluation. In this experiment, among various physicochemical characteristics of yogurt, TA & pH and Organoleptic evaluation of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) were analyzed.

Materials and Methods

1. Preparation of *Oxya chinensis sinuosa* (Grasshopper) powder

Dried *Oxya chinensis sinuosa* (Grasshopper) was purchased from Sworm Co. (Korea), and then was grinded into powder using manual grinder, passed through a 25 mesh sieve, and stored in polyethylene bags at −20℃ until use.

2. The preparation of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper)

Powder of *Oxya chinensis sinuosa* (Grasshopper) was added to yoghurt premix at concentrations of 0% (control), 0.5%, 1%, and 2% and then homogenized (T 25 digital ULTRA- TURRAX®, IKA Labortechnik, Staufen, Germany). Lyofast YAB 450AB (Sacco srl., Codaragok, Italy) consisted of *Streptococcus thermophilus, Lactobacillus delbrueckii* ssp. *bulgaricus. Lactobacillus acidophilus* and *Bifidobacterium animalis* ssp. was inoculated and then fermented for 5 h at incubator (Fig. 1). After finished fermentation, the high- protein yoghurt was stored at 4℃ for 24 h until analyze.

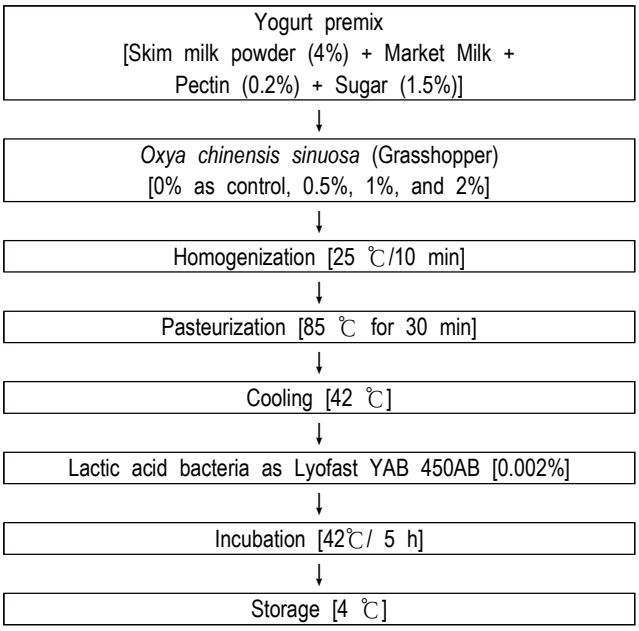

Fig. 1. Procedure for the manufacture of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper).

3. The pH & TA of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) powder

The pH of the homogenized high-protein yoghurt was determined using a digital pH meter (Orion Star A211, USA). Before measuring pH, the detector was calibrated with pH 4 and pH 7 buffer, respectively. And titratable acid (TA) was determined by titration with 0.1 N NaOH. The high-protein yoghurt sample (3 g) was transferred into an Erlenmeyer flask containing 27 mL of dH2O. Three to five drops of 0.1% phenolphthalein as pH indicator were added. Then, the high-protein yoghurt mixture was titrated with 0.1 N NaOH with continuous stirring until a stable pink color was achieved. The amount of acid produced during fermentation was calculated as follows:

$$\text{Total TA (\% Lactic acid)} = \frac{\text{Dilution factor} \times V_{NaOH} \times 0.1\ \text{N NaOH Factor} \times 0.009}{\text{Weight of sample (g)}} \times 100$$

Where V_{NaOH} is the volume (mL) of 0.1 N NaOH required to neutralize the acid; a dilution factor of 10 was used.

4. The organoleptic evaluation of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) powder

Table 1. A five-point hedonic scale for organoletpic evaluation

A five-point hedonic scale	Attributes
1, extremely poor; 2, poor; 3, fair; 4, good; 5, excellent	
The higher the intensity of the bitterness, the lower the score	Taste
The higher the intensity of yoghurt's flavor, the higher the score	Flavor
The higher the intensity of the white color, the higher the score	Color
The higher the intensity of yoghurt's texture, the lower the score	Texture
The higher the total score, the higher overall acceptability.	Overall acceptability

The organoleptic evaluation was carried out by 10 trained panelists between 20 and 40 years of age. The samples were coded with three digit numbers and randomly served at < 10℃ in plastic cups (10 mL). All assessors completed a test assessment form to compare the five sensory attributes (appearance, flavor, taste, and overall acceptability) by using a five-point hedonic scale (1, extremely poor; 2, poor; 3, fair; 4, good; 5, excellent) (Table 1).

5. Statistical analysis

Two separate experiments with dulicate assays were performed. GraphPad Prism 5 (USA) was used for all data analyses. ANOV (Analysis of variance) was used to determine the significance of major effectiveness, and also Duncan's multiple range test was used to determine the differences between means. Statistical significance was considered at $p<0.05$.

Results and Discussion

1. The pH & TA of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) powder

According to the results of previous experiment, the pH was generally decreased to approximately 4.3 or 4.4 after the fermentation of yoghurt premix (Data not shown). In this study, the pH value of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) powder (0.5% to 2%) showed similar to that of control group without *Oxya chinensis sinuosa* (Grasshopper) powder (Data not shown). Also, the value of TA was increased to about < 1.0% after the fermentation of yoghurt premix (Data not shown). The TA contents of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) powder (0.5% to 2%) showed similar to that of control group without *Oxya chinensis sinuosa* (Grasshopper) powder (Data not shown). The high-protein yogurt added with *Oxya chinensis sinuosa* (Grasshopper) powder showed TA contents in the range of 0.93 to 1.1%. There was not any significant difference between control and treated group in pH and TA.

2. The organoleptic evaluation of the protein-fortified kefir added with *Oxya chinensis sinuosa* (Grasshopper) powder

The organoleptic evaluation of the high-protein yoghurt was evaluated by 10 trained panelists of ages 20 to 40 years, and the results are summarized in Table 2.

The high-protein yoghurt was prepared with *Oxya chinensis sinuosa* (Grasshopper) powder at concentrations of 0% as control, 0.5%, 1%, and 2%, respectively. Detailed results of organoleptic evaluation are as follows.

The taste scores for the high-protein yoghurt with *Oxya chinensis sinuosa* (Grasshopper) powder (0.5% to 2%) ranged from 3.31 points to 3.08 points, which were lower than those for yoghurt without *Oxya chinensis sinuosa* (Grasshopper) powder (0% as control) showed 3.41 points. The flavor score of the high-protein yoghurt with *Oxya chinensis sinuosa* (Grasshopper) powder (0.5% to 2%) ranged from 3.24 points to 2.85 points, whereas that of yoghurt without *Oxya chinensis sinuosa* (Grasshopper) powder (0% as control) showed 3.29 points. The color value of the high-protein yoghurt with *Oxya chinensis sinuosa* (Grasshopper) powder (0.5% to 2%) ranged from 3.17 points to 3.34 points, which was comparable to that of yogurt without *Oxya chinensis sinuosa* (Grasshopper) powder (0% as control) showed 3.01 points. The texture value of the high- protein yoghurt with *Oxya chinensis sinuosa* (Grasshopper) powder (0.5% to 2%) ranged from 3.10 points to 3.34 points, which was comparable to that of yogurt without *Oxya chinensis sinuosa* (Grasshopper) powder (0% as control) showed 3.09 points. And the overall acceptability decreased with increasing amounts of added with *Oxya chinensis sinuosa* (Grasshopper) powder. Among the experimental group, high scores were received by with *Oxya chinensis sinuosa* (Grasshopper) powder-containing high- protein yoghurt with 0.5% compared with the control group. Summarizing the results, except for color and texture, taste, flavor, and overall acceptability showed the decreased trend in proportion to the added

Table 2. The organoleptic evaluation of the high-protein yoghurt added with *Oxya chinensis sinuosa* (Grasshopper) powder

Addition of *Oxya chinensis sinuosa* (Grasshopper) \ Attributes	Tast	Flavor	Color	Texture	Overall acceptability
0%	3.41±0.63	3.29±0.84	3.01±0.94	3.09±0.82	3.20±0.73
0.5%	3.31±0.57	3.24±0.70	3.17±0.97	3.10±0.98	3.16±0.62
1.0%	3.36±0.70	3.16±0.89	3.25±0.95	3.22±0.97	3.14±0.67
2.0%	3.08±0.79	2.85±0.91	3.34±0.94	3.34±0.89	2.91±0.74

All points are expressed as mean (±SD) of duplicate determinations.
Within a row, means with different superscripts are significantly different ($p<0.05$).

amount of *Oxya chinensis sinuosa* (Grasshopper) powder. In 2017, the proximate composition of *Oxya chinensis sinuosa* (Grasshopper) was analyzed by Kim *et al.* (2017). The moisture of *Oxya chinensis sinuosa* (Grasshopper) was 8.7 (%), dry matter was 91.3(%), Ash was 44.0 (g/kg dry weight), fat was 30.3 (g/kg dry weight), protein was 742.8 (g/kg dry weight), carbohydrate was 182.9 (g/kg dry weight), and energy was 16.6 (MJ/kg dry weight). Also in mineral concentration of *Oxya chinensis sinuosa* (Grasshopper), Ca was 1,086.9, P was 6,513.1, Mg was 1,025.6, Zn was 110.0, Fe was 99.7, Cu was 27.2, Mn was 48.2, B was 15.2, and Mo was 1.5 (mg/kg dry weight) (Kim *et al.* 217). These data suggested that edible insects may be a useful source of dietary protein and minerals (Rumpold and Schlüter OK. 2013).

In conclusion, the high-protein yoghurt added with 0%, 0.5%, 1%, and 2% of *Oxya chinensis sinuosa* (Grasshopper) powder showed the decreasing trend of pH and the increasing pattern of TA. Also the high-protein yoghurt containing 0.5% to 2% concentration of *Oxya chinensis sinuosa* (Grasshopper) powder received higher scores in color and texture among Organoleptic evaluation. Hence, further studies are required to produce the health-improving yoghurt using by *Oxya chinensis sinuosa* (Grasshopper) powder as resource of protein and mineral.

Disclaimer

The views expressed herein do not necessarily reflect those of the US Food and Drug Administration or the US Department of Health and Human Services.

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