GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gsconlinepress.com/journals/gscbps/

(RESEARCH ARTICLE)

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# Effects of sterilization temperature and time on the average sensory scores, physicochemical properties, microorganisms and antioxidant activity of bird's nest beverage

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GSC Biological and Pharmaceutical Sciences, 2023, 23(01), 016–022

Publication history: Received on 21 February 2023; revised on 31 March 2023; accepted on 03 April 2023

Article DOI: https://doi.org/10.30574/gscbps.2023.23.1.0139

## Abstract

Salanganes'Nest is one of the well-appreciated foods (sea cucumber, fish fin, abalone, and bird's nest) in the Southern-East region. This study focused on the variation of mean sensory scores, physicochemical properties, and microbiological and antioxidant activities. This study focused on the variation of mean sensory scores, physicochemical properties, and microbiological and antioxidant activities under different pasteurization temperatures (105, 110, and 115 $^{o}$C) and time (15, 20, 25, 30, and 35 minutes) conditions. The results showed that pasteurization temperature and time affected the evaluated objective functions. The tested indexes of bird's nest water were the best at 110 $^{o}$C for 35 minutes, for example, (free radical scavenging activity of 73.32$^{b}$ ± 0.34% and total antioxidant activity of 1.22$^{b}$ ± 0.02 (mg AA/ml product)). Bird's nest will be a potential drink in anti-aging to enhance human health.

**Keywords:** Antioxidant; Beverage; Salanganes' Nest; Sensory; Sterilization; Physic-chemistry

## 1. Introduction

Swallows live in limestone caves around the Indian Ocean, South and Southeast Asia, Northern Australia, and the Pacific Islands. For about 1,200 years, the Chinese have eaten bird's nests as soup. Bird's nest is known to have high nutritional and medicinal value, anti-ageing [1], anti-cancer, improvement of concentration and libido increase [2]. Bird's nest contains all the essential amino acids [3]. They have six hormones, including testosterone and estradiol. Bird's nest also contains carbohydrates and small amounts of lipids (naturally occurring molecules including fat). Bird's nest contains substances that can stimulate cell division and tissue growth and regeneration, as noticed in previous studies [3, 4].

In Vietnam, these nests distribute from the Yen islands in Khanh Hoa, Binh Dinh and Quang Nam. The food source for swiftlets is quite rich and diverse, and a suitable climate for birds. Vietnam's bird's nest was only 90 nests per kilogram, while in Malaysia (110-120 nests to get 1 kilogram of oats). The colour of Vietnam nests is whiter than that of Malaysia and Thailand. The production of bird's nests in Vietnam is only about 10 tons/year, equivalent to 10% compared to other countries in the region. Specifically, the production of bird's nests in Indonesia is about 100 tons/per year, and about 60 to 70 tons/per year in Malaysia and Thailand, respectively. The statistics show that Vietnam annually produces about 3.000 kg bird's nests [5-7].

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The beverages segment is estimated to get revenue of US$235.00bn (in 2023) with a growth rate of 12.80% and a projected market volume of US$380.50bn by 2027. User penetration will reach 14.1% in 2023 and 18.3% by 2027, with average revenue per user of US$217.40 [8]. Resulting beverages from bird's nest water is very potential. Beverage production has many factors that affect the quality of drinks, such as pasteurization conditions noticed by previous studies. The current study focused on the average sensory scores, physicochemical properties, microorganisms and antioxidant activity of bird's nest beverages under the impact of sterilization temperature and time.

## 2. Material and methods

### 2.1. Sensory evaluation

Inspect and evaluate product quality by sensory according to TCVN 3215-79 [9] and basic standards. Sensory evaluation results are collected and processed according to the provisions of TCVN 3215-79.

### 2.2. Determination of physic-chemical characteristic

- Determine Brix degree by test method: TCVN 4414:1987 [10].
- Determine the pH according to the test method: TCVN 12348:2018 [11].
- Determination of viscosity was according to the test method: TCVN 9709: 2013/ ISO 7973:1992 [12].
- Quantification of the flavonoid content was according to the test method: NIFC.05.M.138 (HPLC).
- The analysis of apigenin content was according to the test method: NIFC.05.M.235 (HPLC).

### 2.3. Determination of microbiological indicators

- Determination of total aerobic microorganisms according to the test method: ISO 4833- 1:2013 [13].
- Determination of Coliforms according to the test method: ISO 4832: 2006 [14].
- Determination of *Escherichia coli* by test method: ISO 7251:2005 [15].
- Determination of *Salmonella* according to the test method: ISO 6579:2002 [16].
- Determination of *Clostridium perfringens* by test method: ISO 7937:2004 [17].
- Determination of *Staphylococcus aureus* by test method: ISO 6888-3:2003 [18].

### 2.4. Determination of antioxidant activity

#### *2.4.1. Total antioxidant capacity*

The total antioxidant capacity was determined by the Prieto method [19]. To V ml of the sample added to 0.5 ml of water and 3 ml of the reaction solution (0.6 M sulfuric acid, 28 mM sodium sulfate and 04 mM ammonium molybdate) placed at 95 $^{o}$C for 90 min. Measure the reaction mixture at 695 nm. Ascorbic acid was as the standard.

#### *2.4.2. Free radical scavenging ability DPPH*

In principle, the antioxidants react the DPPH radical (2,2-Diphenyl-1-picrylhydrazyl) by giving hydrogen, which reduces the absorbance at the maximum wavelength, and the colour of the reaction solution fades, changing from purple to pale yellow. The lower the optical density OD value, the higher the DPPH free radical scavenging capacity. Free radical scavenging capacity DPPH was evaluated according to the description of Blois [20]. Take V ml of the sample and add 3 ml of 0.16 mM DPPH in methanol. Keeping the mixture was at room temperature for 30 min. Measure the reaction mixture at 517 nm. Calculation formula:

$$SC\% = [1 - \frac{(A_m - A_t)}{A_c} x100$$

Where: $A_c$: Absorbance of the comparison sample (DPPH solution without sample);
$A_m$: Absorbance of the sample (DPPH solution added to the test sample);
$A_t$: Absorbance of the control sample without DPPH.

### 2.5. Experiment design

#### *2.5.1. Sample preparation*

Base materials such as Walocel, Xanthan gum, refined sugar, rock sugar, Stevia and flavouring are mixed and heated from 70 – 100 $^{o}$C. The mixture was stirred and filtered to obtain a homogeneous mixture. After filtering, the essence of

bird's nest, ginkgo biloba, chamomile and glucosamine was mixed with a homogeneous compound and stirred well, conducting heat treatment to remove microorganisms. Then, pour the product solution into the glass packaging.

*2.5.2. Research on suitable heat treatment mode*

In this test procedure, to determine the appropriate heat treatment mode, we study the factors affecting product quality in 05-time modes (15, 20, 25, 30, and 35 minutes) and 03 temperature modes (105, 110, and 115 $^{o}$C). Evaluate the sensory value, physicochemical criteria, microbiological criteria and antioxidant activity of the beverage.

### 2.6. Data analysis

Each experiment was triplicated. Data analysis was analysed using the software MS. Excel 2010, ANOVA analysis of variance method to test reliability with 95% confidence to evaluate the difference of experimental results.

## 3. Results and discussion

### 3.1. Average sensory scores of bird's nest beverage

The statistically significant difference in the average sensory score of a bird's nest beverage at different sterilization temperatures and time conditions did not find. At the temperature (110 $^{o}$C) and time (35 minutes), the color and fragrance of the product were the best. Increasing the heat treatment mode, the sensory score of the product decreases and reaches a low value in test sample 15, corresponding to 115 $^{o}$C /35 minutes. The low sensory score indicates that the color and odor of the product are not absorbed. Table 1 exhibited that the sensory scores of the sterilization products at 105, 115 $^{o}$C, and 15 to 35 minutes were non-significant differences, except for 110 $^{o}$C (Table 1).

The higher the sterilization temperature and the longer the processing time, the greater the variability of chemical components in the product, which will reduce product quality and affect the sensory value of the product more. The results were similar previous studies [21, 22], and it is interesting.

**Table 1** Effects of sterilization temperature and time on the average sensory scores and physicochemical properties of bird's nest beverage

| Order | Temperature ($^{o}$C) | Time (min) | Average sensory point | Brix degree | pH | Viscosity (cP) |
|---|---|---|---|---|---|---|
| 1 | 105 | 15 | 18.5$^{a}$ | 8.54$^{a}$ | 5.43$^{a}$ | 31.54$^{a}$ |
| 2 | | 20 | 18.7$^{a}$ | 8.52$^{a}$ | 5.43$^{a}$ | 31.86$^{a}$ |
| 3 | | 25 | 18.7$^{a}$ | 8.54$^{a}$ | 5.44$^{a}$ | 30.45$^{a}$ |
| 4 | | 30 | 18.8$^{a}$ | 8.52$^{a}$ | 5.45$^{a}$ | 31.38$^{a}$ |
| 5 | | 35 | 18.8$^{a}$ | 8.56$^{a}$ | 5.45$^{a}$ | 32.32$^{a}$ |
| 6 | 110 | 15 | 18.8$^{b}$ | 8.65$^{a}$ | 5.48$^{a}$ | 31.67$^{b}$ |
| 7 | | 20 | 18.8$^{b}$ | 8.67$^{a}$ | 5.49$^{a}$ | 32.59$^{b}$ |
| 8 | | 25 | 18.9$^{b}$ | 8.71$^{a}$ | 5.53$^{a}$ | 34.96$^{b}$ |
| 9 | | 30 | 18.8$^{b}$ | 8.75$^{a}$ | 5.54$^{a}$ | 33.57$^{b}$ |
| 10 | | 35 | 19.0$^{b}$ | 8.80$^{a}$ | 5.56$^{a}$ | 35.94$^{b}$ |
| 11 | 115 | 15 | 18.8$^{a}$ | 8.77$^{a}$ | 5.53$^{a}$ | 32.09$^{a}$ |
| 12 | | 20 | 18.7$^{a}$ | 8.63$^{a}$ | 5.49$^{a}$ | 29.63$^{a}$ |
| 13 | | 25 | 18.6$^{a}$ | 8.58$^{a}$ | 5.49$^{a}$ | 33.16$^{a}$ |
| 14 | | 30 | 18.6$^{a}$ | 8.55$^{a}$ | 5.48$^{a}$ | 30.82$^{a}$ |
| 15 | | 35 | 18.5$^{a}$ | 8.51$^{a}$ | 5.46$^{a}$ | 30.06$^{a}$ |

(*) word a and b exhibited a significant difference between average value, $p<0.05$

Therefore, the optimal temperature mode for product sterilization is 110 °C for 35 minutes. At the condition, the sensory score of the product is achieved the best value while ensuring the preservation of nutritional value, product quality with a viscous liquid, and the light yellow color, characteristic aroma of a bird's nest, a sweet taste, both harmful microorganisms destroying in the product, saving energy, capacity, and production costs.

### 3.2. Effects of sterilization temperature and time on the physicochemical properties of bird's nest beverage

*3.2.1. Brix degree*

Brix value has no statistical difference at a 5% significance level with increasing temperature from 105 to 115 °C and over time from 15 to 35 minutes (Table 1). The Brix of the product gradually increased with the heat treatment from sample 1 to 10 and then decreased slightly to sample 15, but the difference between test samples at all temperatures and research time is not much. Thus, it showed that the heat treatment mode has little effect on the Brix of the product because the heat treatment is only a process to destroy microorganisms, so it does not affect the Brix value of the product much.

In the heat treatment mode of 110 °C for 35 minutes, the product will have the highest sensory level with a Brix of 8.8.

*3.2.2. pH*

When increasing the heat treatment mode, the pH of the product tends to increase and reaches the highest value at sample 10, corresponding to 110 °C/35 minutes, and then slightly decreases at 115 °C/35 minutes (Table 1). The differences were non-significant in heat treatment regimes between the samples at all surveyed temperatures and study times. As for the sensory evaluation criteria of preference, in the heat treatment mode of 110 °C for 35 minutes, the product with a pH of 5.54 was rated the highest.

*3.2.3. Viscosity*

The product viscosity increased and reached the highest value, corresponding to 110 °C/35 min. The product viscosity decreases and reaches a low value at 115$^0$C/35 min when heat treatment increaes. Table 1 showed no significant difference in product viscosity at 105, 115 °C, and 15 to 35 minutes, except for 110 °C (Table 1). For sensory evaluation criteria of preference, in the heat treatment mode of 110 °C for 35 minutes, the product with a viscosity of 35.94 was rated the highest.

### 3.3. Microorganisms

**Table 2** Effects of sterilization temperature and time on the microorganisms of bird's nest beverage

| Order | Microorganisms (CFU/ mL product) | Sterilization time (min) | Sterilization temperature (°C) | | |
|---|---|---|---|---|---|
| | | | 105 | 110 | 115 |
| 1 | Total aerobic bacteria | 15 | - | - | - |
| | | 20 | - | - | - |
| | | 25 | - | - | - |
| | | 30 | - | - | - |
| | | 35 | - | - | - |
| 2 | *Coliforms* | 15 | - | - | - |
| | | 20 | - | - | - |
| | | 25 | - | - | - |
| | | 30 | - | - | - |
| | | 35 | - | - | - |
| 3 | *Escherichia coli* | 15 | - | - | - |
| | | 20 | - | - | - |
| | | 25 | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| | | 30 | - | - | - |
| | | 35 | - | - | - |
| 4 | *Salmonella sp.* | 15 | - | - | - |
| | | 20 | - | - | - |
| | | 25 | - | - | - |
| | | 30 | - | - | - |
| | | 35 | - | - | - |
| 5 | *Clostridium perfringens* | 15 | - | - | - |
| | | 20 | - | - | - |
| | | 25 | - | - | - |
| | | 30 | - | - | - |
| | | 35 | - | - | - |
| 6 | *Staphylococcus aureus* | 15 | - | - | - |
| | | 20 | - | - | - |
| | | 25 | - | - | - |
| | | 30 | - | - | - |
| | | 35 | - | - | - |

Tested microorganisms were not detected in sterilized bird's nest drinks at different temperatures and time conditions (Table 2), which exhibited great significance in food safety. The sterilization temperature from 105 to 115 $^{o}$C and the sterilization time from 15 to 35 minutes is suitable for sterilizing the bird's nest beverage containing the over ingredients. Physico-chemistry of Salanganes'Nest beverage in current study was similar to the notice of Kasidate et al. [23].

### 3.4. Antioxidant activity

**Table 3** Effects of sterilization temperature and time on the antioxidant activity of bird's nest beverage

| Order | Antioxidant | Sterilization time (min) | Sterilization temperature | | |
|---|---|---|---|---|---|
| | | | 105 $^{o}$C | 110 $^{o}$C | 115 $^{o}$C |
| 1 | Total antioxidant activity (mg AA/ml product) | 15 | $0.92^{a} \pm 0.02$ | $1.10^{b} \pm 0.06$ | $1.15^{a} \pm 0.03$ |
| | | 20 | $0.96^{a} \pm 0.01$ | $1.10^{b} \pm 0.13$ | $1.08^{a} \pm 0.04$ |
| | | 25 | $0.95^{a} \pm 0.04$ | $1.16^{b} \pm 0.04$ | $1.07^{a} \pm 0.04$ |
| | | 30 | $1.00^{a} \pm 0.11$ | $1.13^{b} \pm 0.04$ | $0.96^{a} \pm 0.03$ |
| | | 35 | $1.05^{a} \pm 0.06$ | $1.22^{b} \pm 0.02$ | $0.92^{a} \pm 0.04$ |
| 2 | Free radical scavenging DPPH (%) | 15 | $70.66^{a} \pm 0.17$ | $71.45^{b} \pm 0.15$ | $71.60^{a} \pm 0.15$ |
| | | 20 | $70.96^{a} \pm 0.17$ | $71.45^{b} \pm 0.15$ | $71.20^{a} \pm 0.17$ |
| | | 25 | $70.66^{a} \pm 0.09$ | $71.84^{b} \pm 0.09$ | $70.71^{a} \pm 0.39$ |
| | | 30 | $71.45^{a} \pm 0.15$ | $71.60^{b} \pm 0.15$ | $70.56^{a} \pm 0.15$ |
| | | 35 | $71.94^{a} \pm 0.17$ | $73.32^{b} \pm 0.34$ | $70.32^{a} \pm 0.23$ |

*Superscript letter in table 3 exhibited a statistically significant difference between the studied groups, $p<0.05$

The antioxidant activity was different at 110 °C, except for 105 and 115 °C. As the temperature and sterilization time increased, the antioxidant activity of the product (total antioxidant capacity, DPPH free radical capacity) increased. The antioxidant ability increases when increasing the temperature from 105 to 110 °C. Specific results obtained that total antioxidant capacity (mg ascorbic acid/ml concentrate) increased from 0.92 ± 0.02 to 1.10 ± 0.06; DPPH (SC%) increased from 70.66 to 73.32 at 15 minutes (Table 3). At the same time, when increasing the sterilization time from 15 minutes to 35 minutes, the antioxidant capacity also increased. As the sterilization temperature and time increase, the concentration of antioxidants increases, leading to an antioxidant activity increase in the product. That shows that temperature and time affect DPPH free radical scavenging ability. The antioxidant activities did not change significantly when the sterilization temperature increased from 110 to 115 °C because a too-high temperature plus a long sterilization time will affect the antioxidant activity of some compounds, such as polyphenols, vitamin E, and vitamin A. For the above reasons, the temperature of 110 °C for 35 minutes for the ability to remove DPPH free radicals and the total antioxidant capacity was the highest. The antioxidant activity of Vietnamese oats was higher than that of other oats [24].

## 4. Conclusion

Different pasteurization temperatures (105, 110, and 115 °C) and time (15, 20, 25, 30, and 35 minutes) conditions were affected on the sensory scores, physicochemical properties, and microbiological and antioxidant activities. The tested indexes of bird's nest water got the best value at 110 °C for 35 minutes, compared to other conditions. For example, Antioxidant activies such as free radical scavenging activity and total antioxidant activity were $73.32^{b}$ ± 0.34% and $1.22^{b}$ ± 0.02 (mg AA/ml product), respectively. Bird's nest beverage will be an advantage in trade and potential in anti-aging to enhance human health.

## Compliance with ethical standards

*Acknowledgments*

Thank you Khanh Hoa province's Department of Science and Technology for its investment.

*Disclosure of conflict of interest*

No conflict of interest.

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