



---

## Production of corn milk from local corn in Hue city

Huynh Thi Kiem Lien<sup>1</sup>, Nguyen Thi Van Anh<sup>1</sup> and Nguyen Van Hue<sup>1</sup>

<sup>1</sup> Food Technology Department, Hue University of Agriculture and Forestry, Hue University, 102 Phung Hung, Thua Thien Hue, 53000, Vietnam

Corresponding email: [nguyenvanhue79@huaf.edu.vn](mailto:nguyenvanhue79@huaf.edu.vn)

### Abstract

Recently, there is a trend to consume production from plant. The overuse of hormones and stimulants in female cows affected quality of cow milk. The increase of disease involved in consuming cow milk leads to demand of another kind of milk and the milk from plant is a suitable choice. Corn is one of main food crops in Vietnam and Asian country. Its benefits for food production, energy, livestock industry was reported. However, production of milk from corn were not mentioned before. Hue is an old capital city where famous with local food and plants. Our research focused on effect of ripening of corn, ratio of compositions (corn, sugar, additives) on sensory quality of corn milk. The produced corn milk was also investigated its quality.

**Keywords:** corn milk, Hue local food, vegetable milk

### Introduction

Maize is a staple food crop in Hue city, Thua Thien Hue province, Vietnam. Thanks to the water from Huong river and special soil in Con Hen, the local corn, known as Bach Ngoc, have specific taste. Bach Ngoc corn was used to make corn-sweet soup in previous time for royal. Now, corn-sweet soup has been made continuously in traditional food shop. In Thailand, Supavitpatana *et al.* (2010) studied to make yoghurt from corn milk and its shelf-life.

Hue is famous with a large amount of Buddhist pagodas and diversity vegetable food. But, most of the products were handmade. So, production of vegetable drink in bulk is necessary.

Cow's milk allergy was reported (Hochwallner *et al.*, 2014). Thus, vegetable milk is a good choice for people who get allergic with cow's milk. There have been many attempts to produce vegetable such as: soybean milk, sesame milk. However, there are no reports about corn milk product from Bach Ngoc corn.

The purpose of this research were: 1/ find out the suitable harvest time of corn for corn milk production; 2/ find out the suitable ratio of corn extraction, water, refined sugar and additives; 3/ test the quality of corn milk in term of microbial analysis and chemical test.

### Materials and Methods

#### Materials

Bach Ngoc corn was harvested from Con Hen, Vi Da, Hue in the early morning and brought to Post harvest Laboratory in order to prepare for our research. The corn was washed and removed un-edible parts. Then, the corn nut was separated and ready for next steps. Refined-sugar used in these experiments was from Bien Hoa Sugar Factory. Gelatin (E1422) and Carrageenan (E407) were presented by local fermented milk.



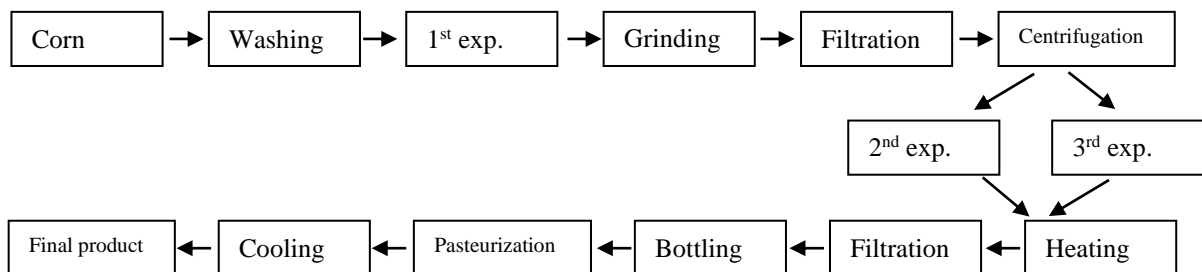
Figure 1. Bach Ngoc corn

## Methods

### *Selection the maturity of corn*

Corn was harvested after 55, 60, 65, and 70 days after planting and then was analyzed some chemical components. The suitable harvest time was chosen based on the time corn have the highest amount of protein, lipid, reducing sugar and vitamin E.

### *Experimental settings of mixing process*



The 1<sup>st</sup> exp.: We would like to study the ratio of corn to water (w/w). The range of that ratio was as follow: corn: water = 1:3 (CT1.1), 1:4 (CT2.1), 1:5 (CT3.1), 1:6 (CT4.1), 1:7 (CT5.1) or 1:8 (CT6.1).

The 2<sup>nd</sup> exp.: Similarity, we change the ratio of refined sugar to corn (w/w). The range of changing was refined sugar: corn = 1:1.5 (CT1.2), 1:2 (CT2.2), 1:2.5 (CT3.2), 1:3 (CT4.2), 1:3.5 (CT5.2), 1:4 (CT6.2).

The 3<sup>rd</sup> exp.: Ratio of additive to corn extraction was changed from 0.2% to 0.5%. In detail, additives: corn extraction = 0.2 % (CT1.3), 0.3% (CT2.3), 0.4% (CT3.3), and 0.5% (CT4.3).

The experiments were carried out triplicate. The sensory results were used for choosing a suitable ratio.

### *Sensory evaluation*

Quality of corn milk were sensory evaluated by using the 9-point Hedonic scale which commonly used for testing customer preference and acceptability of food (Lim, 2011). Four categories: color, smell, taste, and structure were evaluated by 100 trained panelists.

### *Microbiology test*

Corn milk product was microbial test through total aerobic bacteria, *E. coli* and total *Coliforms*, and *Salmonella* ssp. Total aerobic bacteria were tested by enumerating colonies (TCVN 5165:1990). *E. coli* and total *Coliforms* was evaluated by “most probable number” method. *Salmonella* ssp. was test followed TCVN4829:2005.

#### *Chemical test*

Protein, reducing sugar, and lipid were determined by standard method (AOAC, 1984). Vitamin E was determined using reversed phase high-performance liquid chromatography (RP-HPLC) with column type of C<sub>18</sub> (150 mm x 4.6 mm x 5µm), detector PDA, and wave length  $\lambda = 292$  nm. Mobile phase was methanol and distilled water with gradient as follow:

Table 1. Gradient of mobile phase.

| Time (min) | %Distilled water | %Methanol |
|------------|------------------|-----------|
| 0.01       | 20               | 80        |
| 1          | 0                | 100       |
| 10         | 0                | 100       |
| 11         | 20               | 80        |
| 15         | 20               | 80        |

#### *Data analysis*

Results was analyzed by ANOVA. To evaluate the differences between the samples, comparisons were made between the means by applying Duncan’s Multiple Range Test with a significance level of 0.05.

## **Results and Discussion**

### **Effect of harvest time on some components of corn**

The time of harvesting greatly affects the nature of the product as well as the subsequent production process due to the different chemical compositions of corn at different harvesting times. Hanway (1996) reported that the quality of corn depended on the growth of corn plant. Therefore, it is necessary to determine the harvest time. Content of some main chemical components of corn were shown in Table 2.

Table 2. Chemical components of corn in different harvest time.

| Component              | 55 days            | 60 days            | 65 days            | 70 days            |
|------------------------|--------------------|--------------------|--------------------|--------------------|
| Protein (% w/w)        | 3.583 <sup>d</sup> | 3.907 <sup>c</sup> | 4.473 <sup>a</sup> | 4.283 <sup>b</sup> |
| Lipid (% w/w)          | 1.497 <sup>c</sup> | 1.730 <sup>b</sup> | 1.983 <sup>a</sup> | 1.707 <sup>b</sup> |
| Reducing sugar (% w/w) | 4.110 <sup>c</sup> | 4.567 <sup>a</sup> | 4.300 <sup>b</sup> | 4.030 <sup>c</sup> |
| Vitamin E (mg/kg)      | 0.17 <sup>c</sup>  | 0.21 <sup>b</sup>  | 0.31 <sup>a</sup>  | 0.29 <sup>a</sup>  |

(Values in a row followed by different letters were significantly different harvest time (P<0.05)).

From the results of Table 2, it could be seen that the concentration of protein, lipid, reducing sugar and vitamin E increases gradually with the time of harvest. So, by the time corn is too old, the levels of these substances tend to decrease. At 65 days, the highest levels of protein, lipid and vitamin

E were 4.473%, 1.983%, and 0.31 mg/kg, respectively. Milk quality depends primarily on the fat content and protein content of milk. Therefore, we chose to harvest corn at 65 days after sowing.

### Effect of mixing ratio on corn milk quality

#### *Effect of ratio of corn extraction and water*

Water is an indispensable ingredient in milk. The amount of added water affected the flavor, taste, and structure as well as determined the cost of the product. We arranged to investigate the impact of the ratio of materials and water as in exp.1. Sensory results were shown as Table 3. The results shown that CT4.1 (16.67 g corn: 100 g water) is a suitable ratio for corn milk product.

Table 3. Sensory point of corn milk.

| Samples | Sensory point     |                   |                    |                   |
|---------|-------------------|-------------------|--------------------|-------------------|
|         | Color             | Flavor            | Taste              | State             |
| CT1.1   | 4.57 <sup>d</sup> | 6.23 <sup>b</sup> | 5.78 <sup>c</sup>  | 4.69 <sup>d</sup> |
| CT2.1   | 4.54 <sup>d</sup> | 6.23 <sup>b</sup> | 5.76 <sup>c</sup>  | 4.54 <sup>d</sup> |
| CT3.1   | 5.30 <sup>c</sup> | 6.27 <sup>b</sup> | 7.21 <sup>a</sup>  | 5.71 <sup>c</sup> |
| CT4.1   | 6.87 <sup>a</sup> | 6.81 <sup>a</sup> | 6.85 <sup>ab</sup> | 7.49 <sup>a</sup> |
| CT5.1   | 6.18 <sup>b</sup> | 5.02 <sup>c</sup> | 6.58 <sup>b</sup>  | 6.43 <sup>b</sup> |
| CT6.1   | 6.10 <sup>b</sup> | 5.64 <sup>c</sup> | 5.26 <sup>d</sup>  | 4.73 <sup>d</sup> |

(Values in a column followed by different letters were significantly different treatments (P<0.05)).

#### *Effect of ratio of sugar and corn extraction*

Sugar is a type of material used in many processing purposes: improving food value and calorie of food; make the product sweet. Sugar and material ratios are added to the exp. 2. Sensory results of the product are shown in Table 4. From the results of Table 4, we could conclude that there was a little difference in odor and in state of corn milk. The sample of CT2.2 (sugar: corn = 1:3) was evaluated the most favorite by the tester.

Table 4. Sensory point of corn milk.

| Samples | Sensory point     |                    |                   |                    |
|---------|-------------------|--------------------|-------------------|--------------------|
|         | Color             | Flavor             | Taste             | State              |
| CT1.2   | 5.89 <sup>c</sup> | 6.21 <sup>ab</sup> | 6.51 <sup>b</sup> | 5.93 <sup>c</sup>  |
| CT2.2   | 6.92 <sup>a</sup> | 6.55 <sup>a</sup>  | 7.11 <sup>a</sup> | 6.84 <sup>a</sup>  |
| CT3.2   | 6.33 <sup>b</sup> | 6.52 <sup>a</sup>  | 6.26 <sup>b</sup> | 6.43 <sup>ab</sup> |
| CT4.2   | 5.63 <sup>c</sup> | 5.99 <sup>bc</sup> | 5.71 <sup>c</sup> | 6.18 <sup>bc</sup> |
| CT5.2   | 5.73 <sup>c</sup> | 5.83 <sup>bc</sup> | 5.11 <sup>d</sup> | 6.41 <sup>ab</sup> |
| CT6.2   | 5.51 <sup>c</sup> | 5.69 <sup>c</sup>  | 4.11 <sup>e</sup> | 5.96 <sup>c</sup>  |

(Values in a column followed by different letters were significantly different treatments (P<0.05)).

#### *Effect of ratio of additives and corn extraction*

Food additives were used for maintaining the dispersion of two or more ingredients to create uniformity for the product. The ratio of additives to corn was set as mentioned in the 3<sup>rd</sup> exp. From the results of table 5, we concluded that CT2.3 was highly appreciated by testers with scores of 3.37, 7.08, 7.17 and 7.20 corresponding to sensory indicators of color, odor, taste and state, respectively.

Table 5. Sensory point of corn milk.

| Samples | Sensory point     |                    |                   |                   |
|---------|-------------------|--------------------|-------------------|-------------------|
|         | Color             | Flavor             | Taste             | State             |
| CT1.3   | 6.36 <sup>b</sup> | 7.00 <sup>ab</sup> | 7.06 <sup>a</sup> | 6.70 <sup>b</sup> |
| CT2.3   | 7.37 <sup>a</sup> | 7.08 <sup>a</sup>  | 7.17 <sup>a</sup> | 7.20 <sup>a</sup> |
| CT3.3   | 6.52 <sup>b</sup> | 6.63 <sup>bc</sup> | 7.08 <sup>a</sup> | 6.68 <sup>b</sup> |
| CT4.3   | 5.47 <sup>c</sup> | 6.38 <sup>c</sup>  | 6.88 <sup>a</sup> | 5.36 <sup>c</sup> |

(Values in a column followed by different letters were significantly different treatments (P<0.05)).

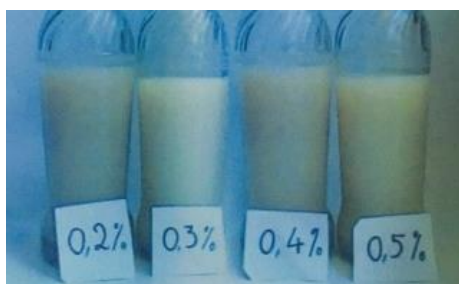


Figure 2. Corn milk product at different ratio of additives

### Quality investigation of corn milk

After choosing the suitable ratio, corn milk was evaluated in term of microbial and chemical test. The results in Table 5 and 6 showed that this product met Vietnamese standard (TCVN). In detail, our products meet microbiological criteria according to TCVN 7041: 2002.

Table 5. Amount of microbiology in 1 mL corn milk.

| Items                  | Results                |
|------------------------|------------------------|
| Total aerobic bacteria | 1.35 x 10 <sup>5</sup> |
| <i>E. coli</i>         | 0                      |
| <i>Coliforms</i>       | 0                      |
| <i>Salmonella</i> ssp. | 0                      |

In general, the sugar and protein content of corn milk (8.7 g and 1.33 g, respectively, in 100 ml of product) is approximately the same as the content in commercial dairy products on the market. Low lipid content in corn milk is a competitive advantage with other high-fat vegetable milk for obese people. Furthermore, for those who are allergic or do not absorb cow's milk, this is a great choice. It has its own characteristics that no other milk has and will be a much-chosen beverage in near future.

Table 6. Chemical components in 100 mL corn milk.

| Component              | Amount |
|------------------------|--------|
| Solid content          | 9°Bx   |
| Protein (g/100 mL)     | 1.33   |
| Lipid (g/100 mL)       | 0.54   |
| Reducing sugar (g/ mL) | 8.7    |
| pH                     | 6.13   |

### Conclusions

- According to the result of this research, we have some conclusions as follow:
- The suitable time for getting good quality of corn is 65 days from planting.



**The 10<sup>th</sup> RMUTs International Conference”**  
**“Creative Innovation and Technology for Sustainable Agriculture”**

- 
- The mixing ratio as follow: corn: water = 1:6, sugar: corn = 1:2, additives: corn extraction = 0.03:100.
  - Corn milk get Vietnamese standard for vegetable milk.

### References

- Hochwallner H., U. Schulmeister, I. Swoboda, S. Spitzauer, R. Valenta. 2014. Cow's milk allergy: From allergens to new forms of diagnosis, therapy and prevention. *Methods*. 66: 22–33.
- Lim J. 2011. Hedonic scaling: A review of methods and theory. *Food Quality and Preference*. 22: 733–747.
- Hanway J. J. 1966. How a corn plant develops. *Special Report*. 38.
- AOAC. 1984. Official Methods of Analysis to determine lipid, protein and reducing sugar content.
- TCVN5165:1990 (Vietnamese standard about “Method for enumeration of total aerobic bacteria in food”)
- TCVN4829:2005 (Vietnamese standard about “Microbiology of food and animal feeding stuffs - Horizontal method for the detection of *Salmonella* spp.”)
- TCVN 7041: 2002 (Vietnamese standard about “Soft drinks”)
- Supavitpatana P., T. I. Wirjantoro and P. Raviyan. 2010. Characteristics and Shelf-Life of Corn Milk Yogurt. *Chiang Mai University Journal of Natural Sciences*. 9(1): 133-149.