The extended shelf life of aloe vera drink with a modified hot-filling practice for the SME

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Abstract. Aloe vera drink is a drink made by soaking aloe vera gel in a sugar solution that has good tastes and health benefits. Aloe vera drink in SME scale has a short shelf life for about two days and must be stored in cold temperatures which resulted in the limited marketing area. This study aims to extend shelf life by modifying the process production that easy to practice for SME. The hot-filling process was chosen because it is suitable for aloe vera drinks and easily applied in the SME. Total microbial, Brix, and pH testing were carried out to ensure product quality during storage. Aloe vera drink process using the hot-filling process can increase the product shelf life of up to 1 month at room temperature with total microbial 28x10^1 CFU/ml, which below SNI-7388-2009 about the maximum limit of microbial contamination.

1. Introduction
For centuries, aloe vera plants have been known for their strong beneficial impact on both external or internal uses for the human body. It has been medicinally used for various ailments treatment such as mild fever, wounds and burns, gastrointestinal disorders, diabetes, and various skin diseases [1]. Moreover, aloe vera plants healthy benefits approved by clinical evidence are reducing low-density lipoprotein (LDL), increasing high-density lipoprotein (HDL), and decreasing blood glucose level [2].

Due to its medicinal properties, Aloe vera has been used as a novel functional food. This food can be made by the utilization of its gel or leaves. Aloe vera gel has become the most popular product [3]. Its gel contained a various range of vitamins such as vitamin A, B-group vitamins, vitamin C, vitamin E and folic acid [4]. Besides, aloe vera gel also contained active chemical compounds such as polysaccharides, glucomannan, and acemannan [5].

The health benefits of aloe vera are distributed inside aloe vera gel. Its gel must be extracted from the leaf with various methods such as leaf splitting, roller squeezing, whole-leaf crushing, hand or machine filleting. Careful post-harvest handling and processing of aloe vera gel are needed to preserve its quality for utilization in food or drink products. Time, temperature and sanitation (TTS) of aloe vera gel processing are a critical requirement that needs excellent attention to ensure the preservation of its shelf life and beneficial active substances [6].

Aloe vera drink has been produced from SME to industrial scale. However, the production of aloe vera drinks in SME is limited due to the short shelf life of the product and the requirement of the cold storage. As a consequence, the market of aloe vera drink produced by SME is limited.
Several methods can be applied to extend the shelf life of aloe vera drink by modifying the filling methods on drink products. The filling process became a key element and had to be considered for ensuring extended shelf life or aseptic packaging concepts are fulfilled in the drinks product production process [7].

Hot-filling technology is widely used for commercial fruit juice products. The steps of hot-filling technology are heating drink products until 95°C about 15-30 minutes, filling and capping at 82-85°C, hold for about 2-3 minutes, heat shocking with cold water, labeling, and ready to storage and distribution [8]. This technology ensured the filling process of products solution to its package is being done with the aseptic condition. Its principle lies in filling heated product from a particular time and temperature conditions into the material packaging end products. Time and temperature adjustment are valuable because it gave a role as microbiological control to avoid spoilage problems [9].

Combined hot filling technology adoption with refrigerator storage conditions below 20°C can be considered as a safe and inexpensive treatment to avoid spoilage in orange juice products [10]. In terms of product stability, there is no significant difference in physical, physical-chemical, and sensorial changes between hot-filling and aseptically processed cashew apple juice across storage periods [11]. Based on that, the modification process in drink production based on time and temperature parameter is done to improve product performance for minimizing the risks of spoilage problems. Meanwhile, it also maintains nutritional product value that becomes the product’s main feature in the market. Therefore, this work aims to improve and increase the shelf life of the product by process modification.

2. Materials and methods

2.1. Materials
Aloe vera gels from Mount Vera Agrotech SME was obtained from Katongan Village, Nglipar District, Gunungkidul, D.I. Yogyakarta. Rock sugar and citric acid were purchased traditional market. Commercial aloe vera, which used for control, was purchased from Superindo. PCA and NaCl for microbial testing were obtained from Merck.

2.2. Methods
This research consists of two steps. The first step was to analyze and control the corrective action. According to the problem, analyzing corrective action was done by literature review and observation on the SME production process. Process modification with the hot-filling process was taken as corrective action for the problem. Process modification using time, temperature, and sanitation as a critical control point of the process. The second step was controlling this corrective action was done by verifying the production results before and after process modification. Total microbial, Brix and pH are tested for ascertaining the modification process results under safe and quality food requirements.

2.2.1. Modification in aloe vera drink production process
Aloe vera leaves were peeled and the gel was cut about 1 cm square and then washed using water to clean gel from mucus. Water was used for the washing process repeatedly to ensure gel clean from mucus. The presence of mucus in the gel will cause low consumer acceptance and shorten the shelf life of aloe vera drink[12].

Then, aloe vera gel was soaked with citric acid until aloe vera gel was used. It needs about 6 hours for soaking. After soaking, aloe vera gel was washed and boiled in water until water is boiling. There was no standard time and temperature for heating the aloe vera gel. Aloe vera gel then placed into a plastic cup and added with sugar solution 12%. Plastic cup with aloe vera gel and sugar solution inside plastic cup then sealed using cup sealer.
TTS parameter used to evaluate the aloe vera drink production process. Plotting the critical point needed to ensure the process meets the requirements. The principle of hot-fill processing for a drink could be used to modify the aloe vera drink production process.

2.2.2. Controlling in aloe vera drink production
Controlling was carried out at the production site and verified at the food and microbiology laboratory of BPTBA LIPI. Control of critical point the aloe vera drink in production site involves testing the temperature using infrared thermometer and pH using pH-indicator strips. Then, testing product in the laboratory involves testing pH values using the Hanna Instruments pH meter, testing the Brix value using a portable refractometer with a range of 0-30 Brix, microbiological testing using the total plate count (TPC) method, and sensory quality including appearance, smell, and taste.

3. Results and discussions

3.1. Experiment to find out suitable hot-filling method for aloe vera
There were several steps to be evaluated according to aloe vera production process on the SME. First, the washing section after the soaking process should be controlled because of its critical step to clean aloe vera gel from mucus. Aloe vera gel that has been cleansed of mucus has better consumer acceptance than aloe vera gel that still has mucus. Moreover, mucus will also shorten the shelf life of aloe vera drink[12]. Second, control will be carried out in the heating process. Heating aloe vera gel in boiling water was needed for a processed product because it can kill spoilage microbes at temperature up to 60°C[13]. Steaming or boiling in water also can reduce unwanted components such as mucus on aloe vera gel[12]. The heating temperature must be controlled because the water temperature will determine the adequacy of heat in killing microbial spoilage in aloe vera gel. From the experiment, we found that the optimum heating time and temperature were about 10 minutes at 65°C. After the heating process, aloe vera gel was immediately soaked in the water with ice cubes below 5°C [6]. This process aims to maintain gel texture and provide shocking thermal effects on microbes that may still be present in aloe vera gel. Next, place aloe vera gel for about 50 grams in a cup. The condition while set aloe vera gel must be a clean place and worker using safety equipment such as gloves, masks, and headgear.

Process modification of aloe vera drink production following TTS principle. Hot-filling process in drink products meets the correct TTS requirement for aloe vera drink production in SME with some modification.

In the previous process, the sugar solution was mixed in a cold state, the pouring temperature before modification about 25°C that allows contamination of microbe that effectively grows at temperature 4-60°C [13]. We suggest pouring sugar solution in the hot condition and using the acidity regulator of citric acid to reduce the potential hazard for the packaged product. The acidity of the drink should be pH below 4.6, so that drink can stable at ambient temperatures. Using the acidity regulator also reduces the potential hazard from high to a moderate level [13]. Sugar solution in aloe vera drink must be at pH about 4 which need citric acid about 1000 ppm or 0.1%. The consequences of using an acidity regulator that the solution becomes sour and reduce the sweet intensity. So, the percentage of sugar added to the solution must be increased.

According to hot-fill processing of drink, temperature while pouring drink should be between 82-85°C. So, the critical point at the pouring step was to ensure the temperature while pouring to cup is about 82-85°C. To ensure temperature achieve 82-85°C, a boiling sugar solution is put into a stainless flask and pour immediately into a cup that already contains aloe vera gel.

Cup quickly sealed and cooled in water with ice cubes at 5° C [6]. Figure 1 shows a modified flow diagram on aloe vera drink production.
This improvement process produces aloe vera drink products with a crisper and non-slimy gel texture when compared to aloe vera drink products before the modification process. It is expected to increase the shelf life of aloe vera drink.

### 3.2. pH and sugar concentration on the product with and without hot-filling process

The acidity of the product / pH and water activity (a<sub>w</sub>) becomes a critical point in processed food products. Foods with neutral pH conditions experience faster decay when compared to foods with high
pH (acid) conditions. Wet foods such as aloe vera drink have $a_w = 1$ and naturally low acidity with pH about 6. Based on figure 2, The pH value of aloe vera drink before modification become decreased during storage. This result was in agreement with Khan et al research that the pH of persimmon fruits decreased during storage[14]. The decrease of pH values indicates microbiological activities that occur during storage.

In the early stages of the hot-filling process, aloe vera drink was to regulate the acidity level. Products with high pH will be effective using the hot filling method[13]. The determination of acidity was carried out based on the desired effective pH value and consumer acceptance. The addition of 0.15% citric acid will maintain a pH of around 4 with a sour taste that was still acceptable to consumers. Aloe vera drink after process modification and commercial in the range pH of 4 until 28 days of storage. It indicates less microbiological activities of aloe vera drink after the hot-filling process and commercial within 28 days of storage.

![Figure 2. pH aloe vera drink during storage](image)

Based on figure 3, the Brix value of aloe vera drink with the hot-filling process was higher than the Brix value of aloe vera drink without the hot-filling process because the addition of sugar changed from 12% b/v to 25% b/v. The concentration of the sugar solution was increased to get the appropriate sweet taste. After 7 days stored in ambient temperature, aloe vera drink without hot-filling process showing signs of decay indicated by the decrease in Brix value. Aloe vera drink with hot-filling process shows Brix stability about 12$^\circ$ until 28 days of storage and commercial aloe vera drink shows Brix stability about 12.5$^\circ$ until 28 days of storage. It proves that aloe vera drink after process modification has Brix stability as in commercial does.
3.3. Sensory analysis to determine consumer acceptance

The sensory observation was carried out involving parameters of appearance, aroma, and taste of aloe vera drink during storage. The aloe vera drink that has changed in appearance was immediately discarded and no need further testing. As table 1 below, before modifications, aloe vera drink only able to survive about 2-3 days in ambient temperature. After 4 days, aloe vera drink no need for further testing with score 1.

| Aloe vera drink          | Appearance | Smell | Taste | Day of observation |
|--------------------------|------------|-------|-------|--------------------|
| Without hot-filling process | 1          | 1     | 1     | 4 days             |
| With hot-filling process  | 6          | 6     | 6     | 28 days            |
| Commercial               | 6          | 6     | 6     | 28 days            |

* Score range 0-7

The hot-filling process using an acidity regulator (citric acid) shows a longer shelf life of aloe vera drink. As shown in table 1, until 28 days, aloe vera drink still had a clear appearance, fresh smell, and refreshing taste performed with score 6 that means still suitable for consumption until one month. Aloe vera drink with hot-filling process had the harm risk lower than low acidic foods. High acidic food has no chance of dangerous bacteria, bacterial spores can’t grow, no public health risk, and enough with pasteurization [13]. Hot filling treatment can replace the pasteurization process in high acidic food [10]. The theory proved by the quality of the product still good for about 28 days according to sensory observation.

3.4. Effect of modification on product microbiological

To ensure product safety, proper consumer acceptance testing must be followed by microbiological analysis using the total plate count method. The microbial analysis results in table 2 show that total microbes on aloe vera drink after modification less than $1 \times 10^2$ CFU/ml as the maximum limit of microbial contamination on SNI-7388-2009 about the maximum limit of microbial contamination. It means aloe vera drink after process modification still suitable to consumed until one month (28 days). The number of total microbes in aloe vera drink after process modification less than commercial does.

| Aloe vera drink | Day monitoring (CFU/ml) |
|-----------------|-------------------------|
| Commercial      |                         |
Without hot-filling process: 
- day 0: <1x\,10^{11}
- day 7: <1x\,10^{11}
- day 14: *
- day 21: *
- day 28: *

With hot-filling process: 
- day 0: <1x\,10^{1}
- day 7: <1x10^{1}
- day 14: <1x\,10^{1}
- day 21: <1x\,10^{1}
- day 28: 28x\,10^{1}

Commercial: 
- day 0: <1x\,10^{1}
- day 7: <1x\,10^{1}
- day 14: <1x\,10^{1}
- day 21: <1x\,10^{1}
- day 28: 45x\,10^{1}

*has not tested because the sample already rotten on 7 days

4. Conclusion
The modified process can increase aloe vera drink product shelf life in small-medium enterprises scale. Hot-fill processing concept adoption to change aloe vera drink production process proven that it can improve its product performance. This process modification also applicable to the SME scale because we focused on utilizing the TTS parameter that can be easily understood by its workers.

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