# Sensory, Chemical, and Microbial Characteristics of Lemongrass (Cymbopogon citratus Stapf.) Beverage Products

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ABSTRACT

*The production and consumption of ready-to-drink health beverages have increased in recent years because of greater demand for health benefits. Central Philippine University (CPU) engaged in a study of lemongrass (Cymbopogon citratus Stapf.) with Kalamansi-Ginger formulation to determine its sensory, chemical and microbial characteristics. Methodology involved sensory analysis in terms of turbidity, flavor and general acceptability; chemical analysis in terms of citral content, titrable acidity and anti-oxidant activity; and microbiological analysis in terms of total counts of bacteria and fungi, as well as shelf-life. Generally acceptability mean scores for sensory evaluation of beverage samples decreased with longer storage period in both room temperature and controlled temperature. Chemical analysis on citral content, titrable acidity and antioxidant activity changed through time, with freshly prepared beverages having the highest values. Microbial analysis revealed fungi count but no bacterial count for a formulation stored in glass bottles. Shelf-life is 17 days for both ambient room conditions at 27ºC average temperature and at controlled incubator temperature. These characteristics make lemongrass acceptable as a ready-to-drink beverage product for production and consumption.*

*Keywords: anti-oxidant activity, lemongrass drink, shelf-life, sensory analysis*

## Introduction

Production and consumption of non-carbonated beverage drinks have increased in recent years due to the growing consumer preference for health drinks over carbonated drinks.

In the Philippines, the government through the Department of Education (DepEd) has even issued a policy banning the sale of carbonated, sugar-based synthetic or artificial, juices in school canteens. (DepEd 2007)

More discerning and informed consumers now take an interest in ready-to-drink (RTD) beverages with health benefits, such as those from natural medicinal sources and those containing high antioxidants. In recent years, the

fastest growing beverage category based on total percentage volume is RTD tea and is expected to grow continuously. (Haffner, 2011)

Lemongrass (*Cymbopogon citratus* Stapf.) or *tanglad* is one health drink that has long been used for its many medical benefits as remedy for high blood pressure, general body weakness, and debility. The lemongrass, when used with ginger as a decoction, can be applied to treat stomach ache, flatulence and indigestion (Quisumbing, 1978; Onaylos, 1984; Ticzon, 1996).

Many studies have shown that lemongrass possesses antioxidant activity (Vinitketkumnuen et al., 1994; Suaeyun et al., 1997; Ojo et al., 2006). The essential oil of lemongrass contains citral, which is reported to possess antioxidant (Rabbani et al., 2005), and anticancer properties (Dubey et al., 1997; Dudai et al., 2005). Thus, the lemongrass beverage could become a healthy alternative to soft drinks not just for school children but for the general public as well.

A previous study showed that the tea prepared from fresh and dried lemongrass plants by decoction and infusion contains citral, as well as, high amounts of antioxidants (Villalobos, 2010).

The preparations and conditions to obtain high amounts of citral and antioxidants on decoctions from fresh lemongrass sheaths have been previously studied (Villalobos & Nocal, 2013) and were used as bases in the study by Gico, et al. of sensory evaluation, antioxidant activity and citral content determination of different RTD lemongrass beverage formulations.

Sugar and lemongrass concentrations were fixed for the final beverage products and results showed that the flavour variants with the highest antioxidant activity were the *kalamansi*-ginger and *dalandan*, while all flavour variants had high citral contents (Gico et al., 2013).

With the final formulations already identified, Lemongrass is a potential ready-to-drink beverage. This study provided an analysis on the sensory, chemical and microbial characterisitcs of Lemongrass to determine the possibility of product commercialization which can generate income for the university, at the same time provide a healthy alternative drink for students and the general public.

**Methodology**

Food quality is described or evaluated regarding qualitative or sensory attributes, chemical attributes, and microbiological attributes (Molnar, 2009). Thus, characterization of the product including microbial analysis to determineits shelf life is necessary not only for quality control but also for packaging considerations, and as part of package development study.

Below is an illustration of the shelf-life evaluation of the product.

**Shelf-life Evaluation of the Product**

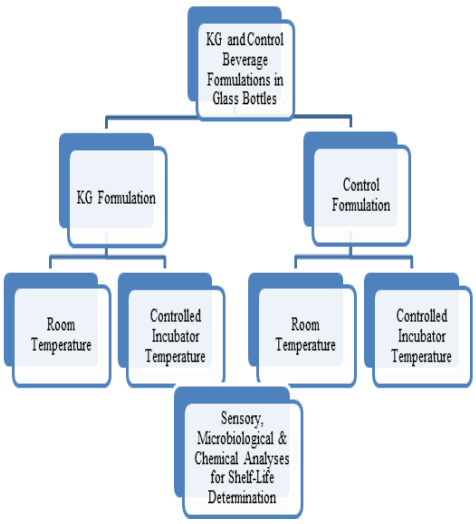


*Figure 1. Experimental Set-up for Shelf-Life Testing and Analysis*

**Product Preparation and Filling**.

Two sets of beverage product samples were prepared and bottled for shelf life determination; the*Kalamansi*-Ginger (KG) formulation which was a patented lemongrass beverage with *kalamansi* and ginger formulation, and the Control Formulation(CF) which was unflavored lemongrass beverage. A 380-glass bottle with metal lug-style closure and shrink band was used for shelf-life testing to withstand hot-filling operations.

***Sensory Analysis***

Sensory analysis was carried out using trained panelists. Properties evaluated and analyzed were turbidity, flavor, and general acceptability. Turbidity and flavor were evaluated using a descriptive analysis using a 4-point rating scale. General acceptability was rated using a 9-point hedonic scale.

***Chemical Analysis***

Titrable acidity and antioxidant activity were monitored at weekly intervals using three replicates based on reviewed procedures (Wireko-Manu *et al.*, 2010; Zaeoung *et al.*, 2005; Molyneux, 2004). Citral content was determined using gas chromatography analysis.

***Microbiological Analysis***

Test procedures were based on US FDA Bacteriological Analytical Manual (BAM) (Maturin & Peeler, 1998) and laboratory manual in food microbiology (Mallari, 2009). Shelf life in the number of days was determined by the period in days before 1000 CFU/mL on total plates count was reached based on industry standard for acceptable microbiological safety for acidic (pH below 4.5) beverages according to the microbiological regulations of European Union (EC No. 2073/2005) (Walkling-Ribeiro, et al., 2009. Microbial decontamination in the food industry:.).

***Shelf-life Testing***

The samples were stored at two different conditions: at ambient room of average 27ºC temperature (RT) inside the CPU-packaging laboratory storage area, and at controlled conditions of constant 32ºC temperature (CT) inside the incubators. Formulations were then randomly drawn every week for sensory, microbiological, and chemical analyses. Shelf-life was

based on total bacteria and fungi counts.

## Results and Discussion

### Sensory Analysis

#### *Turbidity Sensory Evaluation*

Results of the sensory evaluation for turbidity of lemongrass beverage samples shown in Figure 2 indicate that all the samples were slightly homogeneous with mean scores ranging from 2.25 to 2.5 in the 4-point rating scale even after 22 days of storage at both room temperature and controlled temperature. This means that all the lemongrass beverage samples were not clear. Turbidity (cloud investor haze) can result from colloidal or larger particles that may precipitate in a container.

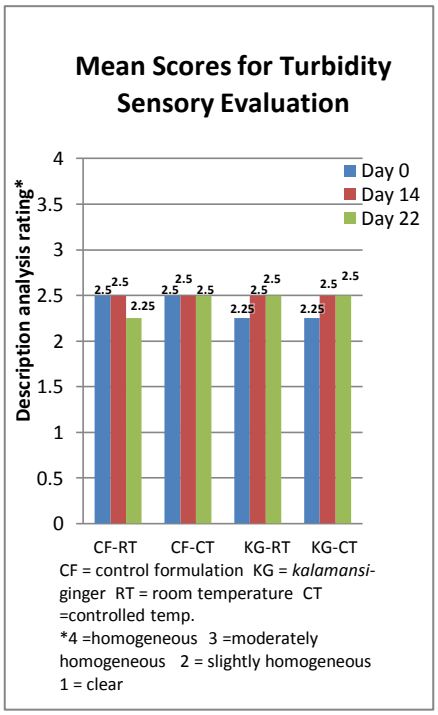


*Figure 2. Sensory Evaluation Results for Turbidity*

#### Flavor Sensory Evaluation

As shown in Figure 3, sensory evaluation results for flavor indicate that generally, flavor diminished with longer storage time. Most foods undergo deterioration following production. The stability of beverages containing citrus juice depends on the raw materials, processing conditions, packaging materials, and storage conditions. These factors cause microbiological and physicochemical changes which further result in an alteration in the flavor of the beverage. Microbial growth, commonly yeasts, causes the production of unpleasant flavors and product deterioration (De Souza et al., 2004).

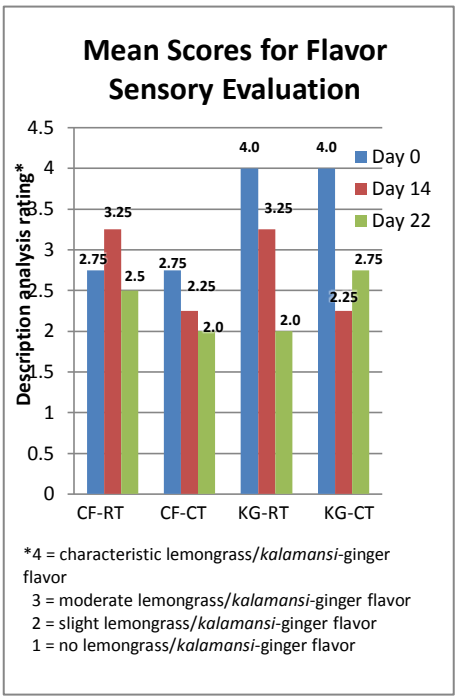


*Figure 3. Sensory evaluation results for flavor*

**General Acceptability**

Results show that generally, acceptability mean scores of beverage samples decreased with longer storage period in both room temperature and controlled temperature. However, even after 22 days of storage, the beverage samples were still moderately acceptable, as shown in Figure 4.

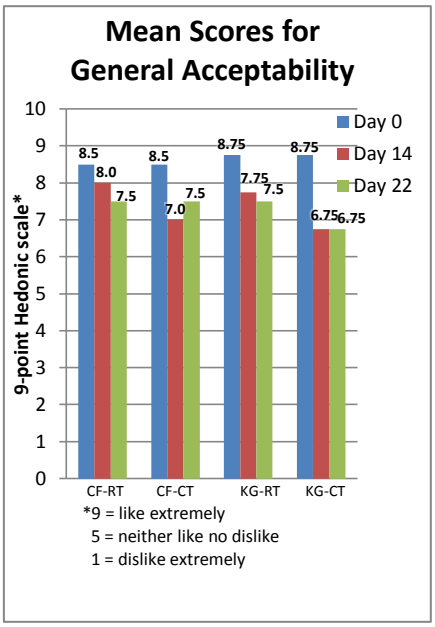


*Figure 4. Sensory evaluation results for general acceptability*

**Chemical Analysis**

***Titrable Acidity***

Figure 5 shows the trend of the acidity of the different formulations when stored at room temperature and controlled temperature at weekly intervals. The CF beverage, stored at both room and controlled temperatures, was more acidic than the KG beverage stored at both room and controlled temperatures. This is because the acidity of the CF beverage was lowered to a pH of 4.5 and below (% citric acid) so it can be processed using the hot fill method. On the other hand, the acidity of the KG beverage was not lowered because it already had a pH of 3.1 which was within the range of acid foods.

Results further show that the acidity of the control and KG formulations remained the same during the 4-week storage, whether stored at room temperature or accelerated temperature. This means that a three-degree Celsius rise in temperature did not change the acidity of the control, as well as the KG beverage.

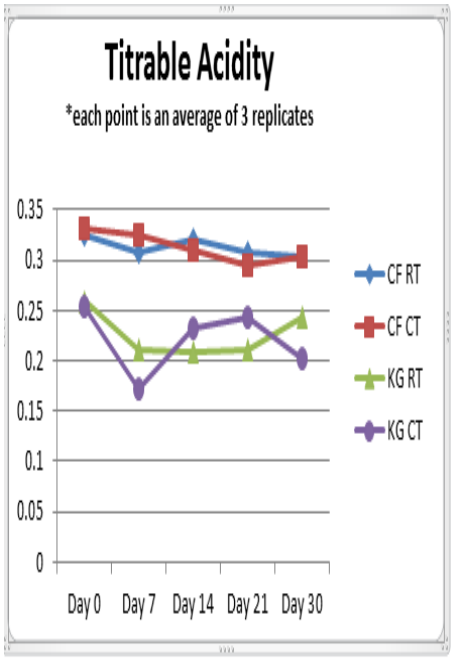


*Figure 5. Chemical evaluation results for titrable acidity*

**Antioxidant Activity**

Figure 6 shows the trend of antioxidant activity of the different formulations when stored at room temperature and accelerated temperature at weekly intervals.

Antioxidant activity changed through time, with freshly prepared beverages (Day 0) having the highest values.

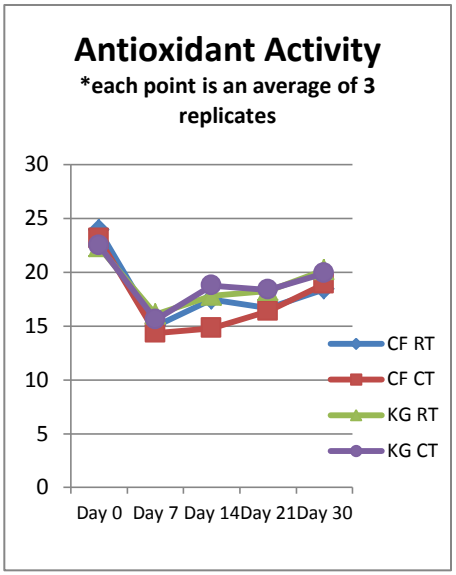


*Figure 6. Chemical Evaluation Results for Antioxidant Activity*

***Citral Content***

Citral content was below the detection limits of the gas chromatography instrument. However, the peaks of the citral isomers geranial and neral, were visible in the chromatogram which signified that citral is still present in the lemongrass beverages but in very low amounts.

**Microbiological Analysis**

Figures 7 and 8 show the colony counts for the CF and the KG beverages, respectively, stored at room temperature and controlled incubator temperature over a span of four weeks. It is evident that there were no bacterial counts at the beginning of storage time (Day 0) in the CF and KG samples at both temperatures.

The pH values of the lemongrass beverages used in these experiments were highly acidic (pH of 2.7 to 3.1) to inhibit the growth of bacteria. Likewise, the type of thermal treatment used in processing the beverages prevented the growth of bacteria (Sonida et al., 2009). However, fungi counts were observed for both CF and KG samples at the start of storage time.

These results are in agreement with the results from microscopic examinations indicating that the major microorganisms in the orange juice were mainly yeast and mold, as indeed citrus juices are most susceptible to yeast and mold spoilage due to their low pH and high contents of sugar and vitamins (Leizerson & Shimoni, 2005).

The shelf life (period in days before 1000 CFU/mL on total plates count was reached)of lemongrass beverage is estimated to be 17 days at both ambient room temperature and controlled conditions.

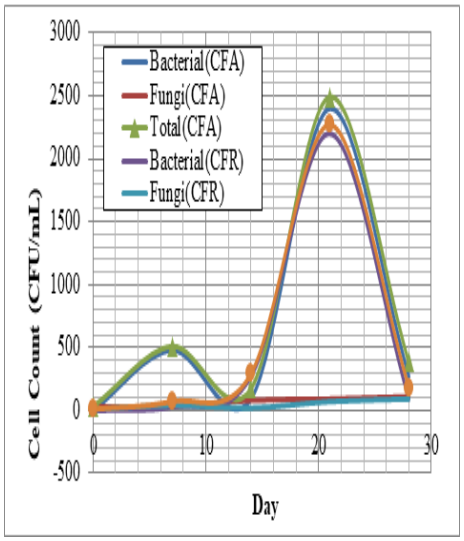


*Figure 7. Microbiological Evaluation Results for Bacteria, Fungi and Total Counts for CFat Room (CFR) and Controlled (CFA) Temperatures*

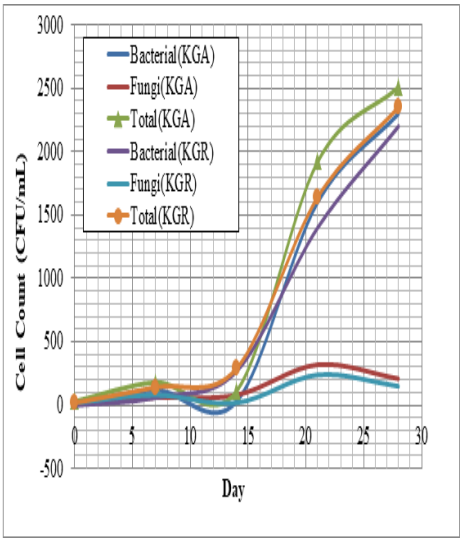


*Figure 8. Microbiological Evaluation Results for Bacteria, Fungi and Total Counts for KG*

**Conclusions**

Shelf life for bottled lemongrass with *Kalamansi*-Ginger formulation is determined to be 17 days at ambient room average temperature (27ºC) and controlled incubator temperature (32ºC) based on microbiological analysis. Generally acceptability mean scores for sensory evaluation of beverage samples decreased with longer storage period in both room temperature and controlled temperature. Turbidity was slightly homogeneous and browning was observed to increase throughout the storage period. The titrable acidity of beverage samples was not affected by the difference in temperature of storage conditions. Antioxidant activity changed through time, with freshly prepared beverages having the highest values.

The relatively short shelf-life of the product and the type of packaging used are the two factors that can still be further studied for analysis and improvement. It is recommended that more studies be done on product and package developments to extend the shelf life of the lemongrass beverage. Improved manufacturing procedures and use of cheaper and lighter bottles that can withstand hot-filling temperatures must be further studied. The product and package launch and the complete business plan and market analysis can be the next steps in the intended commercialization of the product.

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***Funded by the Commission on Higher Education (CHED), Philippines***

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