Development of Coconut Milk Based Yoghurt Enriched with Aloe Vera (*Aloe Barbadensis Miller)* and Hibiscus *(Hibiscus Sabdariffa)* Extracts

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Abstract

Lactose intolerance, vegan preferences and 0consumers on health-conscious diets looking for natural substitutes are driving up demand for dairy-free yoghurt substitutes. Coconut milk (*Cocos nucifera*), abundant in Sri Lanka which provides an ideal base with its creamy texture, potassium richness, fats, carbohydrates, vitamins, dietary fibers and bioactive compounds (flavonoids, phenols) that support *Lactobacillus* fermentation superior to traditional bases. This research developed and optimized coconut milk-based yoghurt enriched with aloe vera (*Aloe barbadensis Miller*) extract for antimicrobial properties and texture enhancement and hibiscus (*Hibiscus sabdariffa*) flower extract for natural anthocyanin coloring (cyanidin-3-sophoroside) and antioxidants. Aloe vera extract (0-20%) and fixed hibiscus extracts were added to coconut milk yoghurt. Physicochemical analysis were conducted by AOAC methods revealed that moisture content increased from 72.20-74.05%, ash from 0.22-0.29%, pH values decreased, while fat (2.06-1.26%) and sugars (14.90-13.60°Brix) decreased with the increase in aloe vera concentration. T_3 (10% aloe vera) had the best flavor, texture, bluish-purple color and overall acceptability, according to a sensory analysis conducted by twenty trained panel members using a 7-point hedonic scale. The antimicrobial properties of aloe vera increased the refrigerated shelf life to seven days. The enhanced nutritional composition, improved physicochemical properties and high sensory acceptability of the coconut milk yoghurt fortified with Aloe vera and Hibiscus extracts make it suitable for use as a functional plant-based alternative to dairy milk based yoghurt, especially for lactose intolerant, dairy-allergic and vegan populations.

Keywords: Aloe vera extract, Coconut milk yoghurt, Consumer preference, Hibiscus extract, Physio-chemical properties, Sensory attributes.

INTRODUCTION

Yogurt is a fermented dairy product that is widely consumed worldwide due to its nutritional and health benefits in addition to its enticing taste. It is typically created by fermenting milk, primarily with *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, which ferment the milk's sugars and give it its distinct flavor (Hadjimbei *et al*. 2022). Yogurt is high in vitamins, protein and minerals and has probiotics that are good for gut health and enhance the body's absorption of nutrients (Sarkar, 2019). Yogurt products are expected to have a smooth, consistent texture and free of lumps and whey separation in order to satisfy the demands and preferences of health-conscious consumers, as well as a clear and distinct taste (Jørgensen *et al*., 2019). The dairy industry has created yoghurt products with reduced or no added sugar and milk fat content in recent years, resulting in healthier choices with the desired characteristics of conventional yogurt (Dias *et al*., 2020).

In Sri Lanka, yogurt consumption is increasing over time as it is believed to have certain health benefits and is easily accessible in a variety of forms. Among all types of yogurt, vanilla-flavored set yogurt is found to be the most popular among consumers across different age groups, genders, lifestyles and cultures (Narayana *et al*., 2019).

However, the market for plant-based yogurt substitutes is growing quickly, while dairy yogurt sales are stagnant or even declining. Millennials and Gen Z, who view non-dairy products as natural, healthful and low in calories are the main consumers of these products (Boeck *et al*., 2021).

People are looking for dairy-free products due to health issues such dairy allergy, high cholesterol, lactose intolerance and the development of vegan diets. Out of the total population, 75% are lactose intolerant and this indicates the importance of dairy free products (Dusabe *et al*., 2021).

Nowadays dairy milk is replaced by coconut milk, peanuts and oats. These improve the yogurt's nutritious content and add to its delectable taste (Nehaa *et al*., 2022). Traditionally, soy milk has been the most popular yoghurt base among plant-based yoghurt varieties but coconut milk is also gaining popularity in recent days (Grasso *et al*., 2020). The high nutritional content of coconut has made it popular since it may be used to fight diseases and malnutrition. Furthermore, coconut copra is a potassium-rich dietary (Mat *et al*., 2022). Apart from being a source of key nutrients coconut meat is rich in protein, fat and carbohydrates, minerals, vitamins, dietary fibers, organic acids, fatty acids and amino acids (Wynn, 2017).

Plants are also being researched as natural sources of food colorants because of their safety, low toxicity, and additional properties such as antibacterial and antioxidant activities (Jabeur *et al*., 2017). Hibiscus commonly found in Sri Lanka are contain anthocyanin which has cyanidin-3-sophoroside as a major compound. Anthocyanin are flavonoids that are soluble in water and have colors that range from orange to blue and purple, which are used as food colorants (Wijesekara *et al*., 2022).

Aloe vera is an extremely popular herb used throughout the world and has a long history of providing numerous health benefits. It is considered a safe herb, both topically and orally. Important bioactive components such as organic acids, lignin, amino acids, glycoproteins, sugars, phenolic compounds, vitamins, enzymes hormones and saponins are also present in aloe vera. Aloe vera is frequently used in food and beverage items due to its natural flavor (Khalel *et al*., 2023).

Non-dairy consumers may be at risk of nutritional shortfalls of calcium, protein, vitamin B12 and vitamin D. While dairy yoghurts naturally provide calcium and vitamin B12 so plant-based alternatives often require fortification to achieve similar nutritional value (Craig and Brothers, 2021).

The current research addressed the difficulties of consuming non-dairy foods by developing a nutrient-dense substitute that can aid in avoiding deficiencies frequently experienced by those with lactose intolerance and dairy allergies. The objectives of this research is to produce a consumer acceptable product that not only satisfies nutritional requirements but also has a desirable taste and texture by fortifying a coconut milk yoghurt with the health-promoting qualities of aloe vera and the natural coloring benefits with hibiscus extract.

MATERIALS AND METHODOLOGY

2.1 Material procurement

The coconut milk was obtained from mature coconuts that are readily available in the area. The hibiscus and aloe vera extracts have been derived from fresh hibiscus flowers and aloe vera leaves that are found in the home garden. The probiotic culture, sugar and gelatin were bought at the Batticaloa local market.

2.1.1 Hibiscus Extract Preparation

The petals were separated on a sterilized tray after the flowers had been thoroughly cleaned. The trays were dried in direct sunlight in a well-ventilated space until they were dry and crispy. About 200 g of sun-dried hibiscus petals was measured and added to 100 ml distilled boiling water for extraction. The petals were left to steep in the water for about 30 minutes, during which time they changed color to a deep purple. After steeping the extract was filtered through cheesecloth to remove solid residues and producing a clear hibiscus extract (Ndiaye *et al*., 2016).

2.1.2 Aloe vera Extract Preparation

Aloe vera leaves both mature and fresh were chosen depending on thickness. After that the leaves were completely washed under running water. In order to the leaves were held upright to allow yellow latex to drain naturally. The leaves' outer green rind was carefully taken out, peeled, mixed and filtered to produce a clear gel extract which stored at 4 °C.

2.1.3 Preparation of coconut milk

Fresh, mature coconuts were chosen which were free of cracks and rotting and coconuts were split open. The coconut flesh was finely grated and placed in a clean basin. Warm distilled water was then added to facilitate the extraction procedure. To extract as much milk as possible, the mixture was blended at high speed for two to three minutes and it was allowed to sit for a few minutes. The thick, creamy coconut milk was separated from the gritty residue by straining the blended coconut mixture through a fine sieve. (Patil *et al*., 2018). The freshly extracted coconut milk was then stored in clean container.

3.1 Development of coconut milk yoghurt enriched with hibiscus and aloe vera extracts

3.1.1 Coconut Yoghurt Base Preparation

After being extracted, the fresh coconut milk was mixed with gelatin, sugar and salt. Hibiscus extract was added to the mixture in the process of heating to give the distinctive color naturally. In order to pasteurize and eliminate microbiological contamination, the mixture was heated to 85°C for 15 minutes. To facilitate fermentation, the base was chilled to 40°C.

3.1.2 Fermentation process

The coconut milk mixture was inoculated with probiotic cultures, Lactobacillus species at 40°C. Depending on the treatment formulations, different amounts of aloe vera extract were added to the coconut milk base. The samples were then incubated for 8-12 hours in a dark area, allowing to the process of fermentation. In order to maintain quality throughout their shelf life, the yoghurts were refrigerated at 4°C and remained stable for up to 7 days.

3.1.4 Sensory Evaluation

Twenty trained panelists (ages 20 to 45) were assessed the sensory characteristics, including taste, color, texture, overall acceptability and flavor. Samples were coded to prevent bias and assessed on a 7-point hedonic scale. Evaluations were conducted in the Food Laboratory under controlled conditions.

3.1.5 Physiochemical Evaluation

The produced coconut milk yoghurt's nutritional composition was assessed using standard AOAC (2002) proximate analysis techniques for key parameters as protein, fat, moisture, ash, and pH. Each treatment was analyzed in three replications.

3.1.6 Microbiological analysis

The microbiological quality of coconut milk yoghurt analogue was assessed using Plate Count Agar, with total bacterial counts on Nutrient Agar. After serially diluting the samples, 1 ml of each dilution was spread out on NA plates which were then incubated for 24 to 48 hours at 37°C. Using a colony counter, the number of colonies was determined. Observations were recorded over seven days under both room temperature and refrigerated storage to track changes in bacterial growth.

3.1.7 Statistical analysis

Each formulation was tested three times following a Completely Randomized Design (CRD). ANOVA was used to assess the physio-chemical and sensory test data at a significance level of 0.05, and Tukey's test was used to compare mean differences. Minitab 17 software was used for all statistical analyses.

RESULTS AND DISCUSSION

4.1 Physiochemical characteristics of freshly made coconut milk based yoghurt enriched with hibiscus and aloe vera extracts

4.1.1 Moisture Content

Enhancing the yoghurt's flavor, texture and mouthfeel characteristics depends on its moisture content (Xu *et al*., 2022). The moisture content results for the five treatments indicated that there was a significant difference ($p<0.05$) between the yoghurt samples. This has been demonstrated in Table 4.1. The moisture content increased from 72.33% to 74.05%, depending on the amount of aloe vera used. This is comparable to a study conducted by Sengupta *et al*. (2018), where yoghurt with aloe vera had moisture content ranging from 83.44% to 86.09%. In this study, the T_5 formulation had the highest level of moisture (74.05%), while the T_2 formulation had the lowest levels of moisture (72.33%).

4.1.2 Ash Content

An increase in ash suggests an increase in minerals, which may have an impact on the coconut yoghurt's nutritional content and texture (Ahmed *et al*., 2020). As indicated in Table 4.1, the ash content of the five yoghurt sample treatments differed significantly ($p < 0.05$) from one another. There were slight differences in the amounts of ash as the amount of aloe vera increased. Lactic acid bacteria's (LAB) metabolic activity during fermentation may be the cause of this alteration. According to Nwaoha *et al*. (2023), adding more herbal extracts to yoghurt recipes somewhat increased the amount of ash. These modifications may be explained by the minerals found naturally in hibiscus and aloe vera, which enhance the nutritious content of coconut milk yoghurt.

Table 4.1: Ash content and Moisture content of freshly made coconut milk based yoghurt enriched with hibiscus and aloe vera extracts.

Treatment	Moisture (%)	Ash (%)
T_1	72.20 ± 0.10^{bc}	0.22 ± 0.01^{a}
T_2	72.33 ± 0.18^{d}	0.25 ± 0.01^{ab}
T_3	72.46 ± 0.04^{cd}	0.26 ± 0.01^{ab}
T_4	73.46 ± 0.23^{ab}	0.28 ± 0.01^{ab}
T_5	74.05 ± 0.07^{a}	0.29 ± 0.00^{b}
p-Value	**0.000**	**0.016**

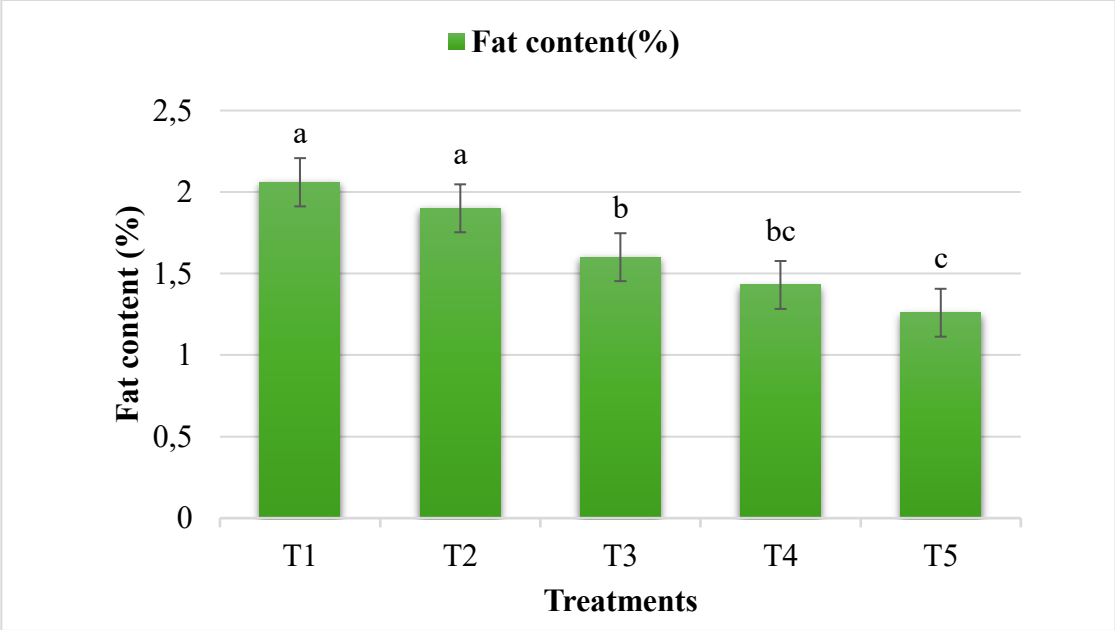
The values are means of triplicates.

The mean values with similar letters are not significant at α=0.05 by Turkey's studentized test.

(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

4.1.3 Fat content

Yogurt's quality characteristics have been demonstrated to be impacted by its fat content. The yoghurt's fat content may affect its texture and may give it a slightly mouth feel if it has low fat content (Akgun *et al*., 2016). For each treatment, the yoghurt's fat level varied between 1.26% and 2.06%. T_1 had the largest fat level (2.06%) whereas T_4 had the lowest (1.26%). Figure 4.1 displays the fat content data for the five yoghurt treatments. It was found that the yoghurt's fat level dramatically dropped as the quantity of aloe vera used increased. This may be caused by the moisture content in the aloe vera, which may have contributed to the dilution of the fat content in the yoghurt.



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The vertical bar indicates the standard error.

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(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

Figure 4.1: Fat content of freshly made coconut milk based yoghurt enriched with hibiscus and aloe vera extracts

4.1.4 Protein Content

Proteins in coconut milk yoghurt, particularly those enriched with hibiscus and aloe vera extracts, are essential in determining the product's quality. Table 4.2 displays the protein content results of the various coconut milk yoghurt samples enhanced with aloe vera and hibiscus extract. Specifically, the protein content in T_1 was the highest at 3.76% and the lowest in T_5 (2.63%).).The protein level of the yoghurt samples in this study was comparatively higher than the 3.5% protein content that is commonly stated for conventional yoghurt (Ehirim *et al*., 2013).This indicates that the enrichment with hibiscus and aloe vera extract may contribute to enhancing the protein profile of coconut milk yoghurt.

Table 4.2: Protein content of freshly made coconut milk based yoghurt enriched with hibiscus and aloe vera extracts

Treatments	Protein (%)
T_1	3.76 ± 0.01^a
T_2	3.29 ± 0.02^b
T_3	3.22 ± 0.16^b
T_4	3.20 ± 0.04^b
T_5	2.63 ± 0.12^c
p-Value	**0.000**

The values are means of triplicates.

The mean values with similar letters are not significant at α=0.05 by Turkey's studentized test.

(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

4.1.5 pH

A lower pH can impact the flavor providing a tangy taste that complements the sweetness of the yoghurt. It also affects the stability of proteins, potentially leading changes in texture and creaminess (Oladipo *et al.,* 2014). T_1 had the greatest pH value (4.45) while T_5 had the lowest pH value (4.07).

The pH findings of the various coconut milk yoghurt samples shown in Table 4.3, which indicates a significant difference among the treatments ($p < 0.05$). The treatments that showed a declining value with the addition of aloe vera extracts had pH values between 4.45 to 4.07. The pH values found in this study align with previous research of Akpan *et al*. (2007) who stated similar pH levels in plant-based yoghurts. The Food and Drug Administration (FDA) recommends that the pH of yogurt not exceed 4.5 (Weerathilake *et al*., 2014). These standards were met by every yogurt sample included in the study.

Table 4.3: pH content of freshly made coconut milk based yoghurt enriched with hibiscus and aloe vera extracts

Treatment	pH
T_1	4.45 ± 0.03^a
T_2	4.27 ± 0.05^b
T_3	4.33 ± 0.03^b
T_4	4.17 ± 0.04^b
T_5	4.07 ± 0.04^b
p-Value	**0.000**

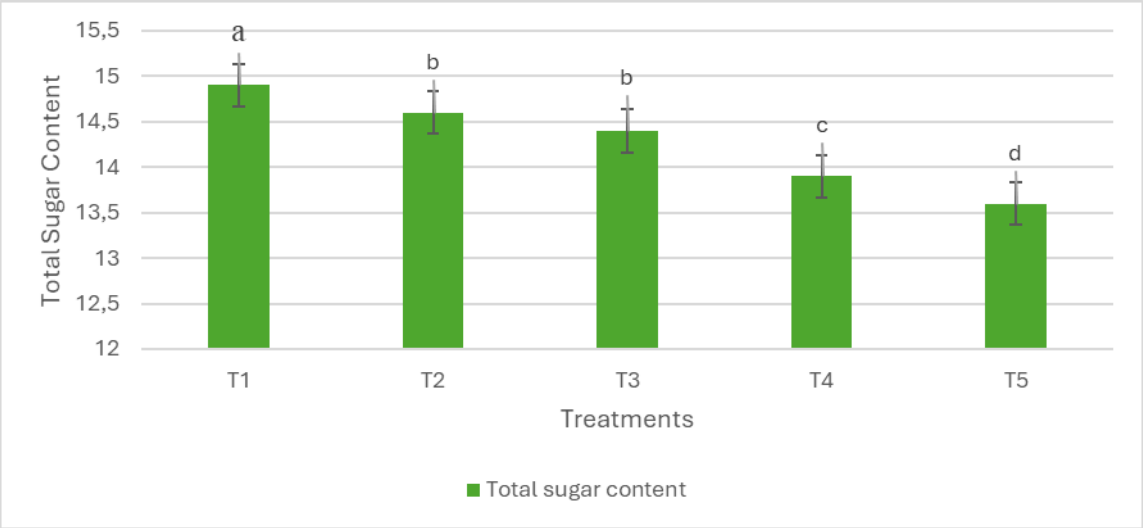
The values are means of triplicates.

The mean values with similar letters are not significant at α=0.05 by Turkey's studentized test.

(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

4.1.6 Total Sugar Content

The coconut milk yoghurt samples' total sugar content, as shown in Figure 4.2, indicated a significant variation across the treatments ($p < 0.05$).T_1 had with the greatest amount of 14.90% and T_5 with the lowest amount of 13.60%. There is a notable decrease in the amount of sugar content as the amount of aloe vera extract increases. This shows that aloe vera extract could have played a part in decreasing the amount of sugar content in the yoghurt. The total sugar content found in this research is consistent in line with results from similar studies on conventional yoghurt (Pagthinathan *et al.,* 2007). Additionally, the total sugar content in all yoghurt samples remained within acceptable limits, maintaining the balance of flavor and sweetness while supporting the product's sensory characteristics.



The values are means of triplicates.

The vertical bar indicates the standard error.

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(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

Figure 4.2: Total Sugar Content of freshly made coconut milk based yoghurt samples enriched with hibiscus and aloe vera extracts

4.2 Organoleptic Quality Analysis of Freshly Made Coconut Milk Based Yoghurt Enriched with Hibiscus and Aloe Vera Extracts.

Freshly prepared coconut milk yoghurt enhanced with hibiscus and aloe vera extract shown significant differences ($p < 0.05$) in the sensory evaluation. Table 4.4 displays the mean values of flavor, color, taste, texture and overall acceptability of the treatments as determined by the Turkey test.

4.2.1 Color

Coconut milk yoghurt is white in natural color (Daszkiewicz *et al*., 2024). However, the addition of hibiscus extract might affect the color due to the pigments present in the hibiscus extract. The mean color score for the sensory evaluation of the various yogurt treatments shows in Table 4.4. The findings showed that there were significant differences ($p < 0.05$) in how the various yoghurt treatments were observed on the basis of color. As a result of the addition of the hibiscus extract, the yoghurt color changed from the original milky white to bluish purple. This finding is aligned to the study conducted by Wijesekara et al. (2022), which discovered that the visual characteristics of a vegan diet dairy substitutes are influenced by plant-derived pigments. T_2 had the greatest mean value

(6.55), while least was obtained by T_5 (3.55), which shows that the amount of hibiscus extract affected the color.

4.2.2 Texture

The range of texture scores of coconut milk yoghurt varied between 3.75 and 6.55 in the different treatments. Highest texture score gotten in T_2 while the minimum texture score was obtained in T_5.The body and texture of yoghurt depend on factors such as total solids content, moisture content, etc. Among the samples T_2 yoghurt was the most preferred, while T_5 yoghurt was the least. All of the samples showed a significant difference ($p < 0.05$). These findings are comparable to those of Gupta et al.'s (2022) study, "Comparison of consumer sensory acceptability linked to textural evaluation of plant and dairy-based yoghurts," which reported texture ratings ranging from 3.44 to 6.90.

4.2.3 Flavor

The sensory evaluation of coconut milk-based yoghurt enhanced with varied amounts of aloe vera extract, which revealed notable variations in flavor preferences between the various treatments was displayed in Table 4.5. The flavor mean ranks of the treatments showed significant variations ($p<0.05$). The flavor scores of the coconut milk yoghurt samples varied between 4.25 and 6.45 across the different treatments. Treatment T_3 recorded highest flavor score of 6.45 and the lowest flavor score of 4.25 was recorded in Treatment T_5. This could be due to the increased aloe vera used in this treatment which might have increased the flavor of the yoghurt that was less preferred by the panelists. . This outcome is comparable to Nazni et al. (2014), where the flavor score was 7.40 for yoghurt.

4.2.4 Taste

Increasing the percentage of coconut milk in yoghurt production led to better taste and aroma values (Sanful *et al*., 2009). The taste scores varied from 3.75 to 6.250 according to sensory tests. While treatment T_3 which had the highest score, was 6.25 and treatment T_5 had the lowest score, which was 3.75. This could be attributed to the fact that T_5 had more aloe vera content which might have had a stronger, slightly bitter taste that was less preferred by the panelists. This is consistent with a research by Niko (2016) that revealed, although by the incorporation with aloe vera is beneficial to improving the functional properties of yoghurt, its excess may result in taste modification and affecting consumer acceptability. Moreover, Sonawane *et al*. (2021) highlighted that the significance of optimizing the concentration of aloe vera in yoghurt, particularly in terms of taste, whether it is dairy or non-dairy yoghurt.

4.2.5 Overall acceptability

Coconut yoghurt enriched with hibiscus and aloe vera has shown promising results in terms of overall acceptability which was displays the mean ranks in Table 4.4. The yoghurt's overall sensory character changed as the aloe vera content raised. T_3 was the most acceptable with a mean rank of 6.60

followed by T_2 with a mean rank of 6.10. Both of these treatments, containing moderate levels of aloe vera which were preferred for their balanced flavor and texture.T_5 was the least liked with a mean rank of 3.85. This suggests that too much aloe vera can create a strong floral and herbal taste which making it less enjoyable for the panelists. T_1 with the lowest concentration of aloe vera, received a mean rank of 5.35, indicating moderate acceptability. This could be due to the higher proportion of aloe vera, which may have affected the flavor and texture. These results were observed by Biswas (2013).

Table 4.4: Result of Sensorial Analysis of freshly made coconut milk based yoghurt samples enriched with hibiscus and aloe vera extracts.

Samples	Color	Texture	Flavor	Taste	Overall acceptability
T_1	5.20 ± 0.24^{a}	5.15 ± 0.25^{a}	4.95 ± 0.23^{a}	5.00 ± 0.26^{a}	5.35 ± 0.28^{a}
T_2	6.55 ± 0.11^{b}	4.65 ± 0.19^{b}	5.75 ± 0.16^{a}	5.65 ± 0.15^{ab}	6.10 ± 0.19^{ab}
T_3	5.95 ± 0.18^{a}	6.35 ± 0.10^{b}	6.45 ± 0.11^{b}	6.25 ± 0.14^{bc}	6.60 ± 0.13^{bc}
T_4	5.05 ± 0.20^{b}	6.30 ± 0.12^{a}	4.85 ± 0.19^{b}	4.75 ± 0.17^{c}	5.00 ± 0.21^{c}
T_5	3.55 ± 0.11^{c}	3.75 ± 0.14^{c}	4.25 ± 0.20^{b}	3.75 ± 0.14^{d}	3.85 ± 0.19^{d}
p-Value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

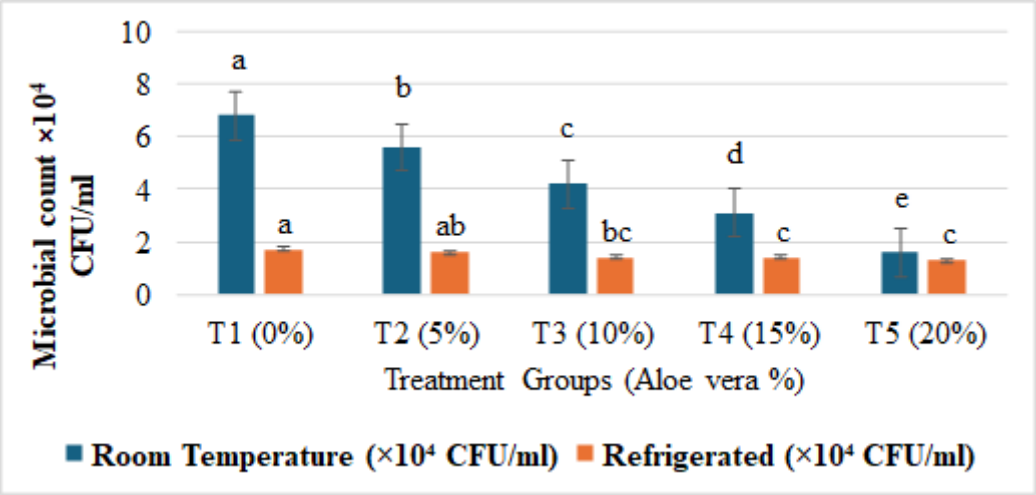
The values are means of triplicates.

The mean values with similar letters are not significant at $\alpha=0.05$ by Turkey's studentized test.

(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

4.3 Microbial analysis of coconut milk based yoghurt enriched with hibiscus and aloe vera extracts.

The plate count showed a decreasing variation with increasing levels of aloe vera extract, may be the reason of antimicrobial properties present in aloe vera. This finding found in the study by Gawade *et al*. (2018). After being kept at room temperature for 7 days, the mean Total Plate Count (TPC) in the samples of yogurt was found to have grown from 1.6×10^{1} to 6.8×10^{1}



CFU/ml. This results from the proliferation of lactic acid bacteria, which is facilitated by the coconut milk. Throughout this research, the yoghurt was considered safe to consumption for up to 2 days and the TPC of yoghurt stored in the refrigerator increased more slowly from 1.3×10^{4} to 1.7×10^{4} CFU/ml over 7 days. The findings are match with Good luck *et al*. (2014) who stated that a bacterial count of 3.0×10^{3} to 10.5×10^{4} CFU/ml is acceptable for yoghurt.

The values are means of triplicates.

The vertical bar indicates the standard error.

The mean values with similar letters are not significant at $\alpha=0.05$ by Turkey's studentized test.

(T_1:0% Aloe vera extract, T_2:5% Aloe vera extract, T_3: 10% Aloe vera extract, T_4: 15% Aloe vera extract, T_5: 20% Aloe vera extract).

Figure 4.3: Microbial analysis of Coconut yoghurt over 7 Days at room temperature and storage under refrigeration

CONCLUSION

Coconut milk-based yoghurt analogue enriched with aloe vera and hibiscus extracts offers a nutritious, dairy-free alternative with strong sensory appeal. In this study, varying ratios of coconut milk and aloe vera (T_1 to T_5) were tested and T_3 (90:10) was most preferred for its balanced texture, flavor and appearance. Physicochemical analysis showed that higher aloe vera levels improved

moisture, ash while slightly lowering protein and fat. Aloe vera improved texture and stability and hibiscus added natural color and antioxidants. Microbial growth in coconut milk yoghurt analogue was influenced by storage conditions and aloe vera levels, with higher aloe vera reducing bacterial counts. The yogurt substitute was safe for up to two days at room temperature and up to seven days in the refrigerator. Its formulation presents a promising commercial opportunity in the expanding plant-based food market, providing health-conscious consumers with an eco-friendly, non-dairy probiotic option.

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