CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This section will discuss the effect of different acidity regulators and the different concentrations on bacterial growth in both the control Nasi Lemak and each tested sample. Additionally, it will explain the impact of acidity regulators on the sensory properties of the control Nasi Lemak and sample of Nasi Lemak with acidity regulators over a period of 24 days.

4.2 Growth of bacteria in the Control Nasi Lemak during 24 days of chilled storage

In the original Nasi Lemak without any additive, as demonstrated in the graph of Figure 4.1a, there was no growth of TPC on Day 1 and Day 8, however, there was an increase from 1.13E+02 to 1.34E+02 cfu.g^{-1} from Day 16 to Day 24 of the experiment. Meanwhile, for *Staphylococcus aureus* in Figure 4.1b, the reading reported on Days 1 and 8 was the same that is 8.00E+00 cfu.g^{-1} but increased to 6.50E+01 cfu.g^{-1} on Day 16 and continued rising to 1.46E+02 cfu.g^{-1} on Day 24. Meanwhile, the growth of bacteria *Escherichia coli* in this original Nasi Lemak consistently showed no reading from 0 to 24 days. Hence, it is determined that pathogenic *Escherichia coli* was absent throughout the experiment in this sample.

Meanwhile, in Table 4.1, it was determined that *Salmonella* was present in every 25 cfu.g-1 beginning Day 8 in the chilled storage.

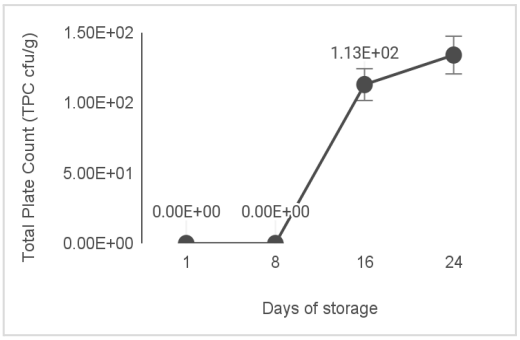

Figure 4.1(a): Total plate count in Control Nasi Lemak during chilled storage on Days 1, 8, 16 and 24.

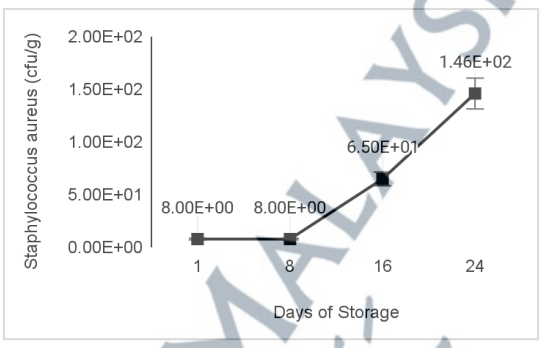

Figure 4.1(b): *Staphylococcus aureus* Nasi Lemak during chilled storage on Days 1, 8, 16 and 24

Table 4.1: Determination of *Salmonella* in different type and different concentration of acidity regulator in Nasi Lemak during chilled storage in Day 1, 8, 16 and 24

Type of acidity regulator	Concentrations of acidity regulator (%)	Days	Presence of *Salmonella* in every 25 cfu.g^{-1}
Control	0	1	Absent
		8	Present
		16	Present
		24	Present
B1	0.5	1	Absent
		8	Present
		16	Present
		24	Present
B2	1.0	1	Present
		8	Present
		16	Present
		24	Present
C1	0.5	1	Absent

		8	Absent
		16	Present
		24	Present
C2	1.0	1	Absent
		8	Absent
		16	Absent
		24	Absent

4.3 Growth of bacteria in Nasi Lemak at different types of acidity regulators and concentrations during 24 days of chilled storage

Differences in acidity regulator types and concentrations significantly affected the bacteria growth as shown in their total plate counts (TPC), and enumeration of *Escherichia coli* and *Staphylococcus aureus* in Nasi Lemak during the 24 days in chilled storage. The original Nasi Lemak does not contain any additive, hence, expected there will be a presence and an increase of growth bacteria during the storage of 24 days in the chiller. As this meal is served onboard and according to World Food Safety Guidelines For Airline Catering, *Salmonella* should not be detected in 25g. Therefore, any sample that has the presence of *Salmonella* is considered out of specification and unsafe to be consumed. Nasi Lemak with acidity regulator Soluex 220302 with 1% concentration in the rice has the least amount of bacteria and demonstrated the slowest growth rate. However, different bacteria have different growth rates in the Nasi Lemak during the 24 days of chilled storage.

4.3.1 Bacterial Count in Nasi Lemak B1 and B2 during 24 days of chilled storage

The results in **Figure 4.2.1a** show the relationship between Total Plate Counts (TPC) in Nasi Lemak with acidity regulator Soluex 220301 0.5% during 24 days in chiller. From Day 1, the reading was 5.60E+09 cfu.g^{-1}, increasing to 2.63E+10 cfu.g^{-1} on Day 8, 1.56E+10 cfu.g^{-1} on Day 16 and 4.22E+10 cfu.g^{-1} on Day 24. Results of Nasi Lemak with added acidity regulator Soluex 220301 1% (B2) show that days of storage and concentration of the acidity regulators markedly affected the growth of bacteria on the Nasi Lemak B2. The results also clearly show that all three factors interacted significantly in affecting the growth of total plate count **(Figure 4.2.2a)**. Initially, the bacterial growth on Day 1 was recorded at 1.71E+08 cfu.g^{-1} before increasing to 3.99E+10 cfu.g^{-1} on Day 8, 1.42E+11 cfu.g^{-1}-1 on Day 16 and shot to 3.00E+14 cfu.g^{-1} on Day 24.

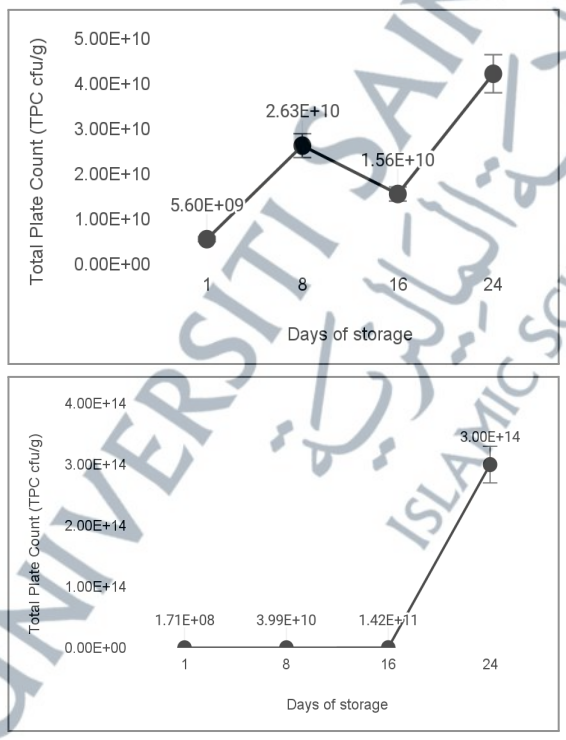

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Figure 4.2(1a): Total plate count (TPC) in Nasi Lemak with added acidity regulator Soluex 220301 at 0.5% (B1) during 24 days of chilled storage

Figure 4.2(2a): Total plate count (TPC) in Nasi Lemak with added acidity regulator Soluex 220301 at 1% (B2) during 24 days chilled storage

Meanwhile, for Staphylococcus aureus, **Figure 4.2.1b** demonstrates that the growth pattern is increasing slowly from 6.00E+03 cfu.g^{-1} on Day 1 to 1.67E+06 cfu.g^{-1} on Day 8 and 5.00E+06 cfu.g^{-1} on Day 16. It increased significantly on Day 24 with the reading of 7.20E+07 cfu.g^{-1}. For *Escherichia coli*, it was not detected from Day 1 until Day 24 of the experiment. Meanwhile, based on the result tabulated in **Table 4.1**, initially, *Salmonella* was absent on Day 1 in the chiller storage, however, it was consistently present starting Day 8 until Day 24 of the experiment.

Results demonstrated in **Figure 4.2.2b** show that the growth of Staphylococcus aureus in sample Nasi Lemak B2 on Day 1 was 6.8E+5 cfu.g^{-1}, which increased to 7.5E+10 cfu.g^{-1} on Day 8 and eventually decreased to 5.7E+5 cfu.g^{-1} on Day 16 before increased back to 9.1E+5 cfu.g^{-1} on Day 24.

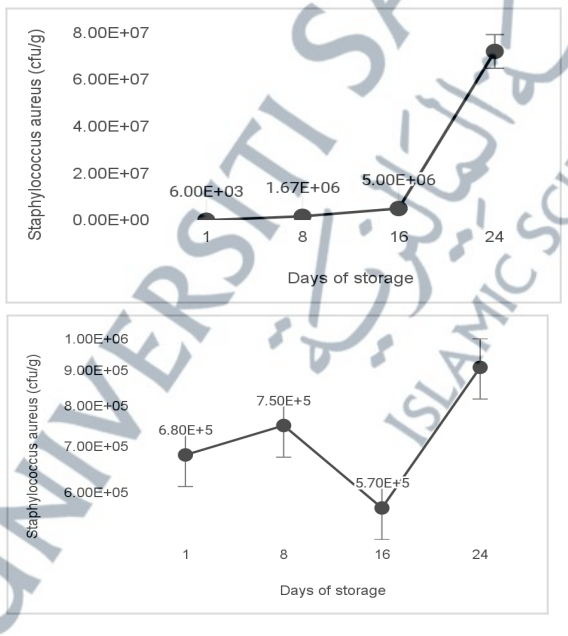

Figure 4.2(1b): *Staphylococcus aureus* in Nasi Lemak with added acidity

Figure 4.2(2b): *Staphylococcus* Nasi Lemak with added acidity regulator

regulator Soluex 220301 at 0.5% (B1) during 24 days of chilled storage

Soluex 220301 at 1% (B2) during 24 days of chilled

4.3.2 Bacterial Count in Nasi Lemak C1 and C2 during 24 days of chilled storage

Total plate counts for Nasi Lemak added with acidity regulator C1 have a similar growth pattern to Nasi Lemak added with acidity regulator B2 but with a higher growth rate towards the end of the experiment. **Figure 4.2.3a** showed that the TPC of bacteria from Nasi Lemak on Day 1 increased from 1.17E+08 cfu.g^{-1} on Day 1 to 1.27 E+10 cfu.g^{-1} on Day 8, then to a slightly higher on Day 16 of 2.22E+10 cfu.g^{-1} before to maximum of 4.60E+17 cfu.g^{-1} on Day 24. Initially, the total plate counts for Nasi Lemak with acidity regulator C2 showed no growth of TPC on Day 1, refer to **Figure 4.2.3b**, and then increase on Day 8 with the reading of 1.58E+10 cfu.g^{-1} before it declined to 1.4E+9 cfu.g^{-1} on Day 16. The bacteria growth increased on Day 24 with a reading of 1.08E+10 cfu.g^{-1}.

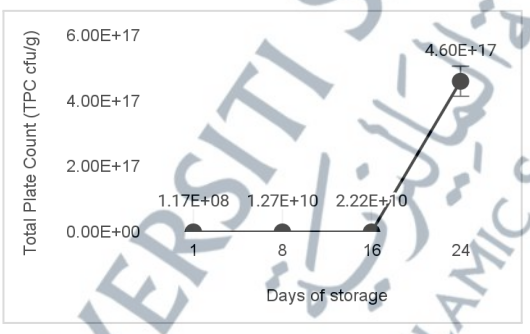

Figure 4.2(3a): Total plate count (TPC) in Nasi Lemak with added acidity regulator Soluex 220301 at 0.5% (C1) during 24 days of chilled storage

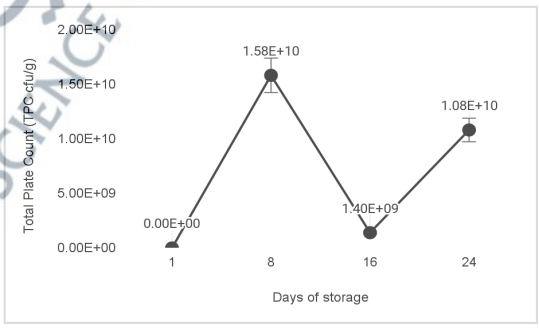

Figure 4.2(3b): Total plate count (TPC) in Nasi Lemak with added acidity regulator Soluex 220301 at 1% (C2) during 24 days chilled storage

However, in **Figure 4.2.4a**, the graph demonstrates a similar pattern as Nasi Lemak C1 that there was no growth of Staphylococcus aureus on Day 1 and 8 but started to appear with reading 8.00E+4 cfu.g^{-1} on Day 16 and increased to 1.90E+5 cfu.g^{-1} on Day 24. The result recorded that there was an absence of *Escherichia coli* throughout the experiment. As targeted, there was no growth of *Salmonella* detected in every 25 cfu.g^{-1} beginning on Day 1 until Day 24, having said that this is the only sample that showed zero *Salmonella* throughout the study period.

Meanwhile, in **Figure 4.2.4b**, the graph demonstrates that there was no growth of Staphylococcus aureus on Day 1 and 8 but started to appear with reading 5.00E+6 cfu.g^{-1} on Day 16 and increased to 1.85E+7 cfu.g^{-1} on Day 24. The result recorded that there was an absence of *Escherichia coli* throughout the experiment. However, *Salmonella* showed an equal pattern with Staphylococcus aureus where there were no growth detected in this sample on Day 1 and Day 8 but started to present consistently on Day 16 and Day 24.

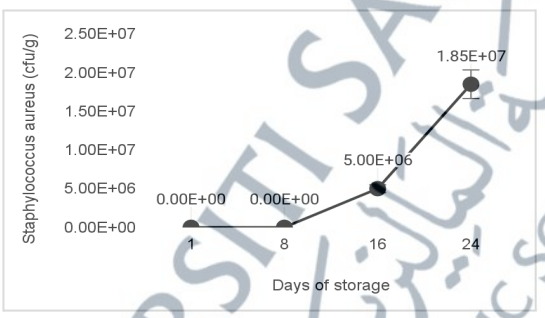

Figure 4.2(4a): *Staphylococcus aureus* in Nasi Lemak with added acidity regulator Soluex 220301 at 0.5% (C1) during 24 days of of chilled storage

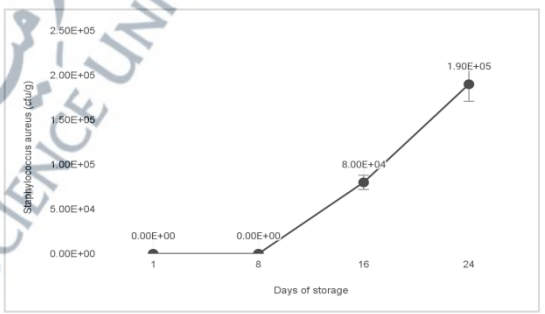

Figure 4.2(4b): *Staphylococcus aureus* in Nasi Lemak with added acidity regulator Soluex 220301 at 1% (C2) during 24 days chilled storage

4.4 Sensory acceptance of the original Nasi Lemak without additive during 16 days in chilled storage

The sensory acceptance of the Nasi Lemak was evaluated by nine trained panelists in RedQ KLIA2 by rating the appearance, aroma, taste, texture and satisfaction and likelihood to order the meal. The rating scale was given 1 to 5 from 'Dislike Strongly' for 1, 'Dislike Moderately' for 2, 'Neither Dislike nor Like' for 3, 'Like Moderately' for 4 and 'Like Strongly' for 5. For Control Nasi Lemak, initially on Day 1, it was rated in the range of 4-5 for overall attributes and the trend declined from Day 8 until Day 24. More detailed information on the questionnaire is available in Appendix 4.1.

As demonstrated in **Figure 4.3**, the meal was rated at an average of 1 on the last day of experimentation. It showed that panelists agreed that the quality of the original Nasi Lemak deteriorated on Day 24. Hence, it is not acceptable by customers. This result is expected in this study, therefore we would like to learn with the use of additive will give impact on the attributes of the meal towards the end of the shelf life.

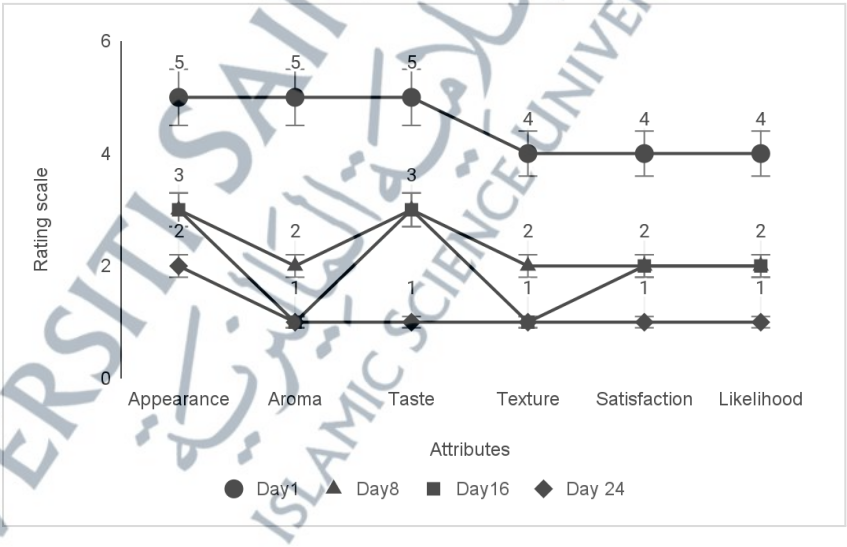

Figure 4.3: Sensory acceptance of the Control Nasi Lemak without additive during 24 days in chilled storage

4.4.1 Sensory acceptance: Nasi Lemak B1 and B2 during 24 days of chilled storage

The results demonstrated in **Figure 4.3.1a** showcase the sensory acceptance of Nasi Lemak with the addition of the acidity regulator Soluex 220301 at a concentration of 0.5%. On Day 1, the attributes of appearance, aroma, texture, and likelihood to order received a rating of 4, indicating a moderate level of liking, while the taste was rated at 3, representing neutrality. As time progressed to Day 8, the ratings exhibited an increase compared to Day 1. On Day 8, the appearance of the rice received a rating of 5, and other attributes were rated at 4. However, starting from Day 16, the results indicated that panelists neither disliked nor liked the aroma and taste of the meals, expressing a neutral stance. The satisfaction level remained average for all attributes. By the last day of the shelf life study, panelists strongly disliked the taste and texture of the meals, expressed strong dissatisfaction with the new recipe, and indicated a very low likelihood of consuming the meals.

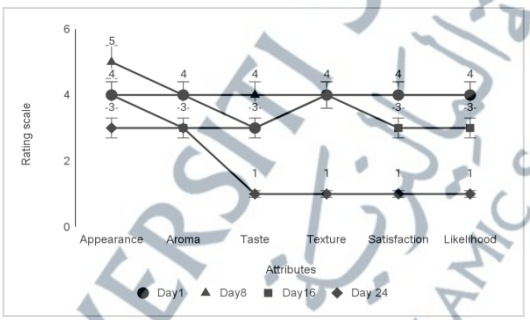

Figure 4.3(1a): Sensory acceptance of Nasi Lemak with added acidity regulator Soluex 220301 at 0.5% (B1) during 24 days of of chilled storage

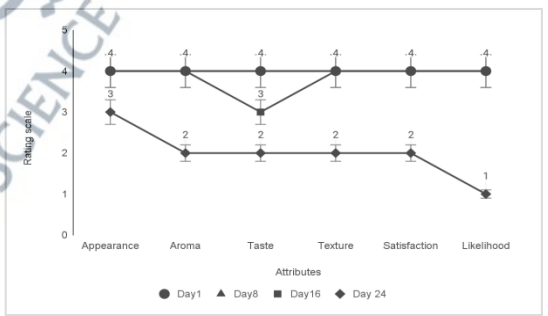

Figure 4.3(1b): Sensory acceptance of Nasi Lemak with added acidity regulator Soluex 220301 at 1% (B2) during 24 days chilled storage

4.4.2 Sensory acceptance: Nasi Lemak C1 and C2 during 24 days of chilled storage

The results illustrated in **Figure 4.3.2a** demonstrate the sensory acceptance of Nasi Lemak with the addition of the acidity regulator Soluex 220302 at a concentration of 0.5%. On Day 1, attributes such as appearance, aroma, taste, texture, and likelihood to order received a rating of 4, indicating a moderate level of liking, while satisfaction with the recipe was rated at 3, representing neutrality. As time progressed to Day 8, the ratings showed minimal changes compared to Day 1. On Day 8, the aroma of the rice received a rating of 3, and other attributes were rated at 4. However, by Day 16, the taste profile had declined, receiving a rating of 2, indicating a moderate dislike. In contrast, the appearance, aroma, and texture were still liked moderately. On Day 24, panelists neither disliked nor liked the appearance, aroma, and satisfaction with the rice recipe, as these attributes were rated at 3. However, the taste and texture received a rating of 2, indicating a moderate dislike. Consequently, the likelihood to consume was also rated at 2, indicating a moderate dislike.

On the other hand, the results presented in **Figure 4.3.2b,** depicting the sensory acceptance of Nasi Lemak C2 with the addition of Soluex 22302 at a concentration of 1% during 24 days of chilled storage, showed no significant difference in sensory perception from Day 1 to Day 8 of the study. The overall attributes were moderately liked on both Day 1 and Day 8. By Day 16, the appearance of the rice, aroma, and taste remained at a rating of 4, indicating a moderate level of liking, while the texture received a neutral rating. Consequently, satisfaction with the

recipe and the likelihood to consume also received a consistent rating of 3 on the same scale

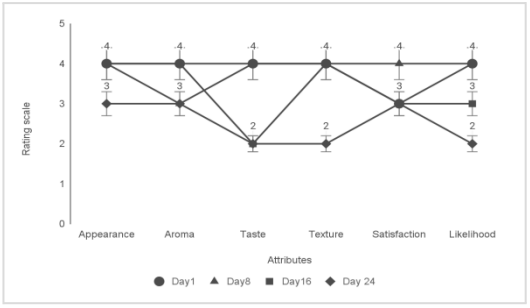

Figure 4.3(2a): Sensory acceptance of Nasi Lemak with added acidity regulator Soluex 220301 at 0.5% (C1) during 24 days of of chilled storage

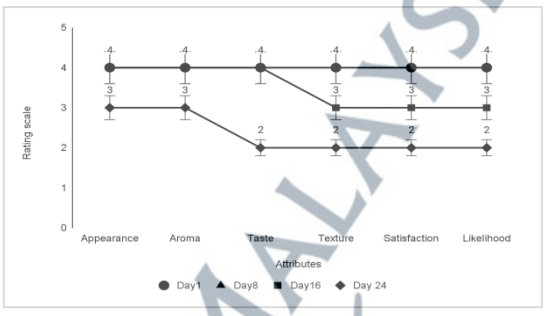

Figure 4.3(2b): Sensory acceptance of Nasi Lemak with added acidity regulator Soluex 220301 at 1% (C2) during 24 days chilled storage

4.5 General Discussion

The significance of water activity in food lies in its regulation of the initiation and intensity of mold spoilage. Notably, foods with elevated water content tend to experience swift deterioration due to both biological and chemical transformations (Abdullah, N., Nawawi, A., & Othman, I., 2000). Due to Nasi Lemak has high content of water which includes coconut milk as the main ingredient, hence answers the original Nasi Lemak in chill storage without additives had a high count of bacterial starting on Day 8 and continued deterioration to Day 16 and Day 24 of the study. This is because there is no control of the water content in the rice hence unable to prevent microbial growth and extend the shelf life of perishable food products like nasi lemak. Realizing the potential risk that may be incurred by spoiled and poor quality rice such as broken or dry rice for human consumption, a study was conducted to investigate the effect of the concentration of acidity regulator and the bacterial count and growth in all Nasi Lemak samples. The water activity level in food plays a key role in influencing the onset and extent of mold spoilage. Foods characterized by high water

content are more prone to rapid deterioration, experiencing both biological and chemical changes (Kornacki, 2010).

The results imply an inverse relationship between the concentration of the acidity regulator and the bacterial count and growth in all Nasi Lemak samples examined in this study. This trend is evident in the growth curves of Total Plate Count (TPC) when comparing sample pairs B1 versus B2 and C1 versus C2. Interestingly, irrespective of whether the concentration of the blend was higher or lower, its presence in the Nasi Lemak formulation consistently prevented the detection of *Escherichia coli* growth in all samples throughout the entire study period. Therefore can be concluded that this acidity regulator has a significant impact on the growth of total plate count in nasi lemak.

On the other hand, it was seen that *Staphylococcus aureus* has a consistent growth curve increasing trend from Day 1 to Day 24 in all nasi lemak samples B1, B2, C1 and C2. The microbial counts enumerated were also high in all samples added with the blend when compared to the control sample.

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